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THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XIV.—No. 331.

ELECTRIC CLOCKS.

SOME of the prettiest mechanical devices which have been imagined may be found in the very numerous varieties of electric clocks which have been brought out from time to time. At both the Paris and the Vienna Electrical Exhibitions the display of timepieces either worked or controlled by electricity was decidedly large. That this should be the case is, we think, a matter of surprise, as the demand for such pieces of apparatus is by no means great, whilst at the best they can hardly be regarded as more than luxuries.

If we really carefully consider the *pros* and *cons* of the question, we can hardly come to any other conclusion than that an electrically-driven clock is a far from satisfactory piece of apparatus. The employment of a battery in the place of a simple spring or weight is certainly not an arrangement which can be said to have great advantages—it has a great number of elements of uncertainty; in fact, we have no hesitation in saying that if the discovery of the possibility of employing a spring or weight for driving a clock had followed instead of preceded the discovery of the possibility of employing a battery for the same purpose, it would at once have resulted in the banishment of the battery.

The study of mechanism is to many a most fascinating pursuit, and the introduction of the electrical element into it to effect certain purposes is also a great source of pleasure, but the practical results which have arisen from the combination of the two have been but very few as regards their application to the working of clocks.

The control of clocks by electrical means has had a considerable amount of success, and this is really the only application of electricity to horology which is justifiable, more especially as it is often the cheapest and most effectual means of making a bad timekeeper go correctly. The use of an electrical controlling arrangement should not, however, be an excuse for employing clocks of an indifferent manufacture in the first instance, as any lengthened failure of the electric control current ought not to seriously affect the correctness of the indications.

While the application of mechanical ingenuity to the electrical driving or controlling of clocks has in many cases resulted in beneficial results, we are of opinion that in a very great many instances it has been misplaced and wasted.

RECENT PROGRESS IN DYNAMO-ELECTRIC MACHINES.*

By Prof. SILVANUS P. THOMPSON.

(Continued from page 242.)

Passing from ring-armatures, I come to another type of machine having disc armatures. The earliest machine of this type was due to the indefatigable Mr. Edison, who built up his disc of radial bars connected at the outer ends by concentric hoops, and at the inner by plates or washers. Each radial bar communicates with the one opposite to it; and the disc thus built up is rotated between the cheeks or pole-pieces of very powerful field-magnets, which very nearly meet, and which therefore yield an enormously powerful field. I cannot hear of any of these disc dynamos having yet come into practical use.

Another type of disc dynamo has been invented by Sir W. Thomson. In this case, the armature is a flat wheel, very like a flattened bicycle wheel. The radial arms or spokes of the wheel, in which the currents are induced, are all connected at their external ends to the copper rim, but at their internal ends are carefully insulated and connected each to a segment of a collector or commutator. As in Edison's disc machine, so also in this, the thin disc rotates between the poles of very powerful field-magnets, which, in the case of Sir W. Thomson's machine, are semicircular in form. Sir W. Thomson also pivots his armature with its axis vertical, and spins it like one of his gyrostats. Unfortunately, the machine has not shown itself to be in practice a success. Its construction necessitates a very high speed, else the electromotive force would be small. If the radial bars, instead of being all joined to one rim, were united by overlapping insulated rims, each one to the one next to that diametrically opposite, and a connection brought round again at the hub to the next but one from that at which the outer rim started, then, applying similar connections all round, the radii would all be connected in circuit, and a much higher electromotive force might be obtained. I am not aware that any disc so connected has yet been tried.

Some improvements have also been made in the Elphinstone-Vincent machine. The sections of the armature of this machine are wound separately in parallelogram forms, and the separate sections are then fixed upon the periphery of a papier-maché cylinder which is mounted so as to rotate between powerful field-magnets and internal field-magnets whose poles reinforce the field. In the improved machines the parallelograms of wire are so arranged that the overlapping ends lie outside the ends of the polar surfaces of the field-magnets, which, therefore, can be brought very close to the surface of the rotating cylinder. Amongst other improvements, also, segments of the collector are internally cross-connected, so that only two brushes are needed instead of six as formerly. Several improvements in mechanical details have also been made.

In alternate current machines something has also been done. The Ferranti-Thomson machine, which, at the date of my Cantor lectures, had just made its appearance, has been considerably perfected. Externally, the machine is scarcely changed at all; the driving pulley being a little larger in proportion. Internally, considerable changes have been made, and in these the hand of the experienced mechanical engineer is apparent.

A very large alternate current machine was shown at the late Electrical Exhibition at Vienna, by Messrs. Ganz, of Buda-Pesth. It was capable of furnishing light for 1,200 Swan lamps (20 candle-power each). This dynamo, which in some points resembled Gordon's well known machine, was constructed according to the Mechwart-Zippernowsky system. The 36 bobbins of the field-magnet were set concentrically on an iron frame, and rotated within an outer circle of 36 armature bobbins. The field-magnet coils were, in fact, the fly-wheel of the high-pressure compound engine which drive the machine and its exciter. The diameter of the rotating part was 2½ metres. A salient feature of this machine is the fact that any one of the coils, either of armature or field-magnets, can be removed from the side of the machine, in case such are needed. The whole fly-wheel can, in this way, be taken down by one man in a few minutes. An electrical efficiency of 85 per cent. is claimed for this machine.

Of one other class of machines—the unipolar dynamo—I had intended to say something. It is a remarkable thing that, though to my knowledge a great deal of attention has been paid lately to machines of this type, no one has yet succeeded in designing a practical unipolar dynamo. There seems to be some hiatus in the theory of this class of machine, for the very singular fact remains that those which are designed in defiance of precautions to avoid wasteful internal eddy currents will work, though badly, and those designed with such precautions will hardly work at all.

There are two or three other new designs for machines which, at present, can hardly be called anything but curiosities. There is, for example, a design for a dynamo by Sir Charles Bright, in which the field-magnet coils and armature stand still, but in which the iron cores and the brushes rotate. There is another design by Professor G. Forbes, in which part of the field-magnets rotate. Mr. C. Lever has designed a machine on somewhat similar principles to the foregoing. I have myself essayed an alternate-current machine, in which both armature and field-magnets stand still, while laminated pole-pieces alone revolve. I hear also of a dynamo designed in the States in which there are no field-magnets, only two revolving armatures.

To sum up, then, it may be observed that in every department under review, the story of the past 15 months is one of solid progress. It has been, it is true, progress of a quiet and perhaps of a commercial rather than a scientific order, yet, as I have shown you, one in which practice and theory have gone hand in hand. It is true that in some few points theory is a-head of practice, but in a still larger number practice is a-head of theory. It would be a great boon to us if our theoreticians could bring up theory to the level of practice in some of the simplest facts. We do not even know the exact law of the saturation of iron in electro-magnets, and content ourselves with formulæ, which we *know* to be incorrect. Of the laws of induction of magnetism in circuits partly consisting of iron, partly of strata of air, or of copper wire, we know very little. We want some new philosopher to do for the magnetic circuit what Dr. Ohm did for the voltaic circuit 50 years ago. There is ample room for progress yet in theory as well as in practice; and the perfection of theory means the deliverance of practice from arbitrary rules of thumb, and from the blunders of inexperience which have so retarded progress in the past. The history of the past 15 months, however, gives great encouragement for the future, because it shows how much may be done, even in the face of great commercial depression, by those whose knowledge and experience give them a deliberate faith in the future, and whose efforts are directed toward no uncertain end. A steady development toward the yet far distant goal of perfection is going on unceasingly. The progress of which I am permitted to be the chronicler to-night is progress of the good and substantial kind, that owes nothing to the excited rush of Stock Exchange speculation, and which, not having been nurtured at an unhealthy fever heat, is destined to be of permanent value.

DISCUSSION.

The Chairman (Mr. W. H. Preece, F.R.S.) said they were much indebted to Professor Thompson for the extremely clear and able manner in which he had brought forward the progress of dynamo-electric history, and he was very much pleased to find that in that progress he had given the first place to practice, and the second place to theory. Professor Thompson had shown how, during the past 15 months' progress, the lead had been taken by practical men; and he had been rather amused at this, because not much more than a week ago he heard him make similar remarks upon a paper brought before the Royal Society by Professor Hughes, one of the most wonderful experimenters and discoverers of the present day. Professor Hughes succeeded, with pins, bodkins, bonnet wire, match boxes, tin kettles, and similar pieces of apparatus, in extracting from nature some wonderful secrets, and he had brought out some very beautiful instruments, which had been the result of incessant toil and constant experiment in every shape and form. Professor Thompson, at the Royal Society, gave the theory after Professor Hughes had shown his instruments, and at the end of the paper expressed surprise that Professor Hughes' instrument accorded with his theory. This was much what he had told them now, though not quite in the same words, that, after all, experience was the only safe guide in teaching one how to make instruments for real practical work; and theory was a very good servant indeed when it came afterwards, and gave a plain, simple, unvarnished tale, which all could understand, to enable them to understand the peculiar action which had taken place. Professor Thompson had alluded to the theory of the dynamo machine, and divided his theories into three —the physical, the algebraical, and the geometrical; and he was bound to say that his own diagramatical representation of the action of dynamo machines, and of the performance of magnetic fields, were perhaps the most interesting part of his paper. The way in which he had worked out the magnetic field had taught everybody more about this subject than they knew before. What Professor Thompson called theory was an explanation—a mode of representing what took place. But a theory was more than that; it was an explanation—a mental picture—of what took place in nature which placed it beyond mere hypothesis; but he objected to applying the term theory to either an algebraical or geometrical description of the actions of the dynamo or any other machine. He, and all other electricians, wanted to have some idea conveyed to their minds of what took place in a wire, in iron, and in the space occupied by the iron and the wire, which produced those marvellous results which they saw in the electric light and in the transmission of force, and to this sense he would confine the word theory.

Mr. Percy Sellon then gave some particulars of the Victoria machine. He said that taking an original Schuckert machine, capable of giving 60 incandescence lamps of a certain power, by substituting four poles for two, the mass of which, both in iron and copper, was very little in excess of that in the original two, and using identically the same ring, they obtained 100 lights, and a much better result in the commutator. From the old Schuckert machine they got a very similar diagram to that which had been shown, among those integrated from Isenbeck's as a bad one with false inductions, the output of the machine being crowded into two bobbins, and on the other side there was a back electromotive force which caused considerable sparking. This was almost entirely removed by the use of four poles, and at the same time the internal resistance was brought down to about one-fourth what it was before. In constructing large dynamos for 500 lights and upwards, they were increasing the number of poles to six and eight, and eventually, probably, they would go to 12 for very large machines. The great advantage of this was that when you brought the poles together you had a given number of lines of force crowded into a very much smaller space; the distance of the centres between north and south polarity were much less, and whilst the number of poles increased, the intensity of the field remained the same, and, therefore, a given length of wire and iron, revolving at a certain speed, would give a decidedly higher result.

Prof. Thompson, in reply, said that he did not agree with the chairman's criticism on his use of the word theory. He thought that he had indicated that these three methods were really three aspects of the theory. The number of lines of force which he had been dealing with might be expressed by a certain length of line, geometrically, or by the symbol *n* alphabetically, or when viewed optically by a mere pictorial demonstration. He had been trying to discover, both from *à priori* considerations and from the teachings of experience, what the principles were which ought to guide practice, and he thought he might claim to have vindicated the claims of theory. It was quite true that theoretical men had been sometimes loth to allow any consideration to practical men; but, on the other hand, practical men would often refuse to have anything to do with theory. The vindication he wanted to put forward was this: in his Cantor lectures, and since, he had been working diligently at the curves of potential round the commutator, and to-night he had connected them with the curves of Isenbeck. Part of the improvement he had noticed in the Schuckert machine was directly due to the advice he had given Mr. Mordey, and to the world at large, on shaping of the pole-pieces to that form which would give the best result on the commutator in respect to the rise of the curve of potentials. Originally the Schuckert machine had great shoes of iron, as pole-pieces, round it, now they were narrowed and tapered. It was found that where you had pole-pieces on the two sides of an ordinary cylindrical Gramme ring, it was better to have them curved round through a large arc, because it gave a flatter field, and the cutting of the lines of force was more regular. Now they were finding that practice was leading in an exactly opposite direction for flat ring machines with the poles at the sides; the shoes were being cut down into little narrow pole-pieces. Theory had led practice to that; and theory, too, had pointed out the relation between the curve of the potential and the induction due to the pole-pieces. After theory had indicated the source of error and a possible means of remedy, they had gone on experimentally cutting down the pole-pieces until they got the proper curve on the commutator. He might further claim, as a vindication of theory, that M. Gramme, who had had 14 years' experience in constructing Gramme machines, and to whom they owed an enormous debt of gratitude, had not yet arrived at the real point which had been reached in England. M. Gramme confessed that this 12 pole machine of his was not yet perfect; and he (Prof. Thompson) had little doubt that the reason was that he had great flat pole-pieces nearly meeting each other. He would stake his opinion on the fact that if he had only made the poles narrower he would have had a better curve of potential, and a machine that did not spark so much. That was the deduction he should draw at once from the potential curve. He claimed that it was entirely admissible to call a generalisation, from which deductions of that kind might be drawn, theory; it was theory in the truest sense of the term, because it pointed the way for practice to follow. He did not require to know what electricity was, or what magnetism was in a piece of iron, or what was the ultimate form of the transfer of force across the space between them, before he used the word theory. He regretted that cold water should have been thrown on his attempt to raise the construction and design of dynamo machines above mere rules of thumb, which were the essence of practice when unenlightened by theory. Practice without theory went on blundering in the dark, and though it was possible to blunder into success it was much more easy to blunder into failure.

The Chairman, in proposing a vote of thanks to Prof. Thompson, said he did not apply the word "theory" in the sense he objected to. He thought that certain geometrical and algebraical investigations were essential in carrying out any practical question, but he objected to the use of the word "theory" to explain what was really better expressed by the word "principle." Prof. Thompson himself used the word "principle," and had detailed the principles that governed the action of the dynamo machines, and it had been in following these principles that such vast improvements had been made. He should like to have heard some description from Prof. Thompson of a class of dynamo machine which was now coming into use daily very largely for the production of copper by the deposit of the metal from its salts. This was being done both at Swansea and at Birmingham. Mr. William Elmore, a hard worker in this field, who had works at Blackfriars, was setting up very large works at Swansea for the extraction of copper from impure ores by this method, and when next Prof. Thompson brought the subject before this society, as he was sure the council would insist upon his doing next year, he hoped that he would pay a little attention to those dynamo machines that were met with in other fields besides the production of electric light and the transmission of power. Again, he was rather disappointed to hear him pass by very lightly the performance of the Hockhausen machine, which was certainly the most distinguished feature of the Fisheries Exhibition. He did not think that that machine had received the attention it deserved, or been studied so carefully by Prof. Thompson as others. Its performance was simply wonderful, and though he had not yet seen the Victoria machine, his own impression was that of all those he had seen the Hockhausen was decidedly the best. Perhaps Mr. Crompton's was an exception, for he had this advantage over Prof. Thompson that he had seen the performance of the Crompton machine. The great lesson to be learnt was this: advance was being constantly made in all these machines, an advance whose future they could scarcely see an end to, and every day they could perceive how, by the combination of theory and practice, they were developing the power of producing electricity to an extent which no one had dreamed of. What with the improvements such as had been mentioned that evening, with improvements in electric lamps and various other appliances, he did not think there was any chance of that end being reached which gas shareholders were so anxious to see.

EFFICIENCIES OF DYNAMO MACHINES.

Through the courtesy of Professor W. G. Adams we are enabled to present to our readers a tabulated series of the tests which were made on various forms of dynamos at the Crystal Palace Electrical Exhibition of 1881—2.

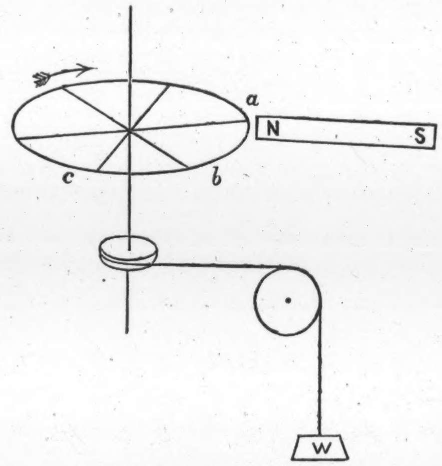
DYNAMOS.	E.M.F. in volts.		C. Ampères.	Resistances.						Speed of dynamo.	Dynamometer.		Electrical energy in Watts.	Energy absorbed per second in Watts.			Percentages.			Electrical energy in H.P.	Energy absorbed in H.P.		
	At brushes or terminals.	Of machine.		Armature.		Field magnet.		Of external circuit.	Of total circuit.		Revolutions of shaft.	Load at 1 foot.		Electrically.	Friction.	Total.	Absorbed power appearing electrically.	Proportion of electrical energy in external circuit.	Absorbed power appearing in external circuit.		Electrically.	Friction.	Total.
				Cold.	Hot.	Cold.	Hot.																
"A" Gramme...	...	98	22·53	...	...	...	...	3·18	4·37	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	71·6	100	24·15	·346	·389	·722	·808	2·96	4·16	1349	383·7	63·7	2,426	3,096	788	3,885	78	71	56	3·252	4·151	1·057	5·208
	...	102	25·76	...	...	...	...	2·78	3·98	...	...	...	...	...	...	...	...	...	...	...	...	...	...
"B" Gramme...	...	120	44·08	...	...	...	...	2·07	2·71	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	105·5	120	43·68	·282	·32	·298	·32	2·10	2·74	...	372·4	103·3	5,221	5,630	1,077	6,705	93	77	71	7·000	7·545	1·444	8·989
	...	119	43·29	...	...	...	...	2·12	2·76	...	...	...	...	...	...	...	...	...	...	...	...	...	...
"H" Gramme, excited by "A" Gramme ...	...	405	13·95	...	...	...	...	26·01	29·06	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	362·8	407	14·49	2·48	3·04	1·26	1·38	25·04	28·08	1087	411·7	137·8	5,898	8,811	1,751	10,560	87	69	60	7·906	11·81	2·348	14·16
	...	408	15·04	...	...	...	...	24·19	27·23	...	...	...	1,756	...	...	...	...	...	...	2·355	...	...	...
	56·8	68	25·94	·346	·389	·722	·808	1·41	2·61	816	...	...	...	...	...	...	...	...	...	...	...	...	...
Brush... ...	683	774	7·38	...	...	...	...	92·58	104·9	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	553·6	670	9·48	4·19	4·87	7·07	7·45	58·41	70·74	811	414·5	166·7	6,352	11,770	1,261	13,031	54	83	45	8·517	15·78	1·690	17·47
Bürgin "B" ...	...	218	20·97	...	...	...	...	7·19	10·41	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	150·8	217	20·57	1·65	1·87	1·31	1·35	7·33	10·55	...	436	91·48	4,465	5,438	1,051	6,489	82	69	57	5·986	7·290	1·409	8·699
	...	215	20·17	...	...	...	...	7·48	10·70	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bürgin "C" ...	...	279	21·84	...	...	...	...	8·53	12·76	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	186·2	277	21·53	2·05	2·26	1·72	1·97	8·65	12·88	...	414·6	112·	5,969	6,960	1,000	7,960	86	67	58	8·003	9·332	1·340	10·67
	...	276	21·22	...	...	...	...	8·77	13·01	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bürgin "C$_3$" ...	...	132	38·30	...	...	...	...	2·424	3·444	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	92·8	132	38·18	·528	·583	·435	·437	2·432	3·452	...	415·9	97·8	5,032	5,745	1,002	6,747	88	70	62	6·746	7·702	1·344	9·046
	...	132	38·06	...	...	...	...	2·439	3·459	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Edison "Z" (wire armature)	...	132	51·01	...	...	...	...	2·54	2·59	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	121·9	133	54·07	·163	·204	40·41	41·54	2·38	2·46	1130	367·3	141·8	7,186	8,742	964	9,706	82	87	71	9·634	11·72	1·29	13·01
	...	133	57·14	...	...	...	...	2·25	2·34	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bar armature ...	60·5	64	146·87	·019	·021	10·10	10·39	·429	·433	1096	361·7	167·	9,336	10,220	1,167	11,387	91	91	83	12·52	13·70	1·565	15·27
Maxim, excited by small Maxim	135·4	152	58·63	·258	·275	·60	·62	2·310	2·585	...	341·6	193·8	8,879	11,120	1,410	12,530	92	77	71	11·90	14·91	1·853	16·76
	32·2	44	32·20	·34	·352	·37	·386	·620	1·358	...	...	...	1,401	...	...	...	...	...	...	1·879	...	...	...
Weston	...	338	22·21	...	...	...	...	12·80	15·25	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	284·3	341	23·29	·958	1·06	1·26	1·38	12·21	14·65	...	365·8	153·7	7,942	9,310	1,000	10,310	85	83	71	10·65	12·49	1·337	13.83
	...	344	24·37	...	...	...	...	11·67	14·11	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Arago Disc (White House Mills)	...	377	16·84	...	...	...	...	15·58	22·41	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	262·4	383	17·66	2·80	2·85	3·68	3·98	14·86	21·69	939	352	142·9	6,763	7,924	1,380	9,304	85	69	58	9·066	10·62	1·850	12·47
	...	389	18·48	...	...	...	...	14·20	21·03	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Arago Disc ...	...	456	11·75	...	...	...	...	31·98	38·81	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	375·9	456	11·74	2·80	2·85	3·68	3·98	32·01	38·84	1080	394·9	125·0	5,355	7,408	1,548	8,956	72	82	60	7·179	9·932	2·075	12·01
	...	456	11·73	...	...	...	...	32·04	38·87	...	...	...	...	...	...	...	...	...	...	...	...	...	...

A NOVEL MAGNETIC ENGINE.

Mr. Chas. McGee, of Michigan University, sends the following interesting note to our American contemporary *Science*:—

It is a well-known fact that iron, when heated to a red heat, ceases to be magnetic; so that an armature, after being heated to redness, may be removed from its magnet by the expenditure of only a small fraction of the energy which is developed by the attraction of the same armature when it has cooled.

Manifestly this fact might be employed in the construction of a motor, which, while of no practical value, is of theoretical interest, in which a permanent magnet should act as the direct motive force. This has been done in the following manner. In the figure, *a, b, c*, represents a ring 13 centimetres in diameter, and supported horizontally upon radial arms and an axis of some non-magnetic metal. This ring is made of one or more turns of iron wire of about a millimetre diameter. N, S is either a permanent or an electro-magnet. The axis is furnished with a driving-pulley, cord, and weight, as shown in the figure.



That part of the ring which lies between *a* and *c* is heated to bright redness by means of two or three Bunsen burners. The magnet then exerts a preponderating attraction upon the farther or cool side of the ring, and the latter revolves as indicated by the arrow. As fast as the ring enters the space *a, b, c*, it becomes red-hot and non-magnetic, and a lack of equilibrium is thus maintained, which results in a continuous rotation.

The motion is necessarily quite slow on account of the considerable time required to heat the iron ring. In the actual experiment, moreover, considerable difficulty was experienced from the distortion which the ring underwent when softened by the heat, in consequence of which the speed of rotation became very irregular. With a permanent steel magnet, a speed of about one revolution in two minutes was obtained; and with a powerful electro-magnet, a weight of six grams was raised 50 centimetres in six minutes, and, in a second experiment (the ring having become quite distorted), 90 centimetres in 30 minutes.

Of course, the source of energy is the Bunsen burners; and the experiment leads at once to the fact, that the specific heat of magnetised iron is greater than that of unmagnetised.

ON THE PROGRESS OF ELECTRIC LIGHTING.*

By WILLIAM HENRY PREECE, F.R.S.

At a recent meeting, held in the City, to determine the future of a prominent electric lighting company, the principal speaker is reported to have said: "Electric lighting was at present a failure, and the sooner the public were made aware of it, the better for their pockets." This statement is not only an egregious fallacy, but an absolute untruth. Electric lighting is a most pronounced success. What has proved a disastrous failure is, electrical company-mongering, and electric lighting finance. The money-making world has been too eager to reap the benefit of the patient student, the ingenious inventor, and the observing engineer.

The progress of electric lighting, from a financial point of view, has been disgraced by the commission of every possible crime that commercial immorality could invent, and every foolish act to which insane speculative mania could lay itself open; but from a practical point of view it has been steady and sure. At one time I contemplated in this paper, entering somewhat largely into the commercial side of the question. I had prepared a list of every company that had been promoted, floated, or wound up, but on further consideration I saw no advantage in crying over spilt milk. The evil that has been done could not be undone. History would soon again repeat itself. If any other fresh invention were to spring up to threaten the prosperity of some well-established interest, stockholders would be frightened, mania would set in, financiers would flourish, and money would freely change pockets.

There is no doubt, however, that the disgraceful financial operations, and remarkable gullibility of the investing public, of the past two years, have materially checked the progress of electric lighting by destroying confidence in its success, and thereby withholding the sinews of war by which alone ultimate success can be secured. With millions thrown in the gutter, it is not to be wondered at that investors button up their pockets when the words electric light is mentioned; but leaving aside the question of the gross mismanagement which has allowed immense sums to be squandered, I propose briefly to indicate some of the progress made, both in a scientific and practical sense, and to show that electric lighting is a real, true success.

On August 18th, 1882, an Electric Lighting Act, promoted by the Board of Trade, received the Royal Assent and became law. Its effect has been to add considerably to the expenses of those who are struggling against difficulties. Its object was to prevent the possibility of the formation of such a gigantic monopoly as that of water and gas. It has effectually done this, but by strangling the babe.

One hundred and six provisional orders were applied for last year, 69 were granted, but at the present moment deposit has not been paid on one single undertaking, and, therefore, not one single installation has been carried out under the provisions of the Act. Of the 69 provisional orders granted, 14 were given to local authorities themselves, but not one has been carried out.

Ten applications for licenses were received by the Board of Trade, but none were persevered with, and, therefore, none have been granted. No form of license has yet been issued. It is intended that their restrictions shall be less onerous, and their operation shall be more tentative in their character than those of provisional orders. They will be granted for seven years, to be renewable at the end of that period.

Some modification will have to be made in this Act. It is all in the interest of one class, viz., the local authority. The fear of the repetition of the gas and water monopoly has evolved restrictions that render commercial enterprise difficult. No cautious inventor would embark his capital in business which, if successful, will at the end of 21 years be confiscated, and, if unsuccessful, will be thrown on his hands, while no local authority will take the bull by the horns and do the work itself while there is the prospect of someone else doing it for them. Ever changing local authorities are very chary of investing ratepayers' money in tentative schemes, and cautious speculators will not risk money in what must be either practical confiscation or doubtful gain. The City of London has gone so far as to ignore the Act, and to invite tenders to light the streets, and to supply houses without any restriction whatever. Other corporations will, perhaps, do the same. Capital can be attracted only by gain. If the gain is to be thickly spread over a few years, the public will suffer. If it be only thinly spread, the capital will not come, and the public will equally suffer. Hence the operation of the present Act is detrimental to the public good.

As regards the scientific progress little has to be said. We had learnt nearly all we wanted to know before electric lighting had entered its practical stage. In reality, the very fact that it had entered its practical age was a proof that it had passed through its infancy of scientific tuition. The conditions that determined its production, the laws that regulated its behaviour, the means that were available for its control, had all been thoroughly investigated and laid down, before practice stepped in to show us what could be done.

Electricity can be produced, currents can be distributed, light can be generated, but we have yet to learn how all this can be supplied economically, profitably, and with safety to person and to property. Practice alone can determine these points, and it is well to make a rapid survey of the extent to which practice has up to now enabled us to solve these points. The future of electric lighting is now in the hands of practical men.

Electric lighting has called for motors of a class not hitherto in demand, and steam, gas, and water engineers have rushed to the front to meet the demand. The production of electric currents means the expenditure of power; and when the extent of the installation is known, it is a simple calculation to specify how much horse-power is needed. Some employ a fall of water to urge a turbine, others employ steam, many use gas to obtain the power requisite to convert the energy of mechanical motion into that of electric currents. Gas-engines are being very largely used, and since the expenditure of a given amount of gas as power, will produce more light through the agency of electricity than by direct combustion in air, it is clear that we have here an evidence of the true function of gas. The perfect gas-engine has not yet been produced. Those in use are too noisy, too irregular, and sometimes uncertain, but the advances made are very marked and very encouraging. The hall in which we are is, as you see, brilliantly illuminated by a gas-engine. Those little lamps, though electric glow lamps, are in fact lighted by gas, though the gas itself is consumed in the cellar. The light we enjoy is only a form of the energy which has been brought into this building by the Gas Light and Coke Company. In all cases of electric lighting electricity is merely the agent which transforms the pent-up energy contained in water, steam, or gas, into that of light. Hence it is that so much of the efficiency of electric lighting apparatus depends upon the instrument called the "dynamo," by which the conversion of this energy is brought about, and here it is that so much inventive skill has been expended, and so much real progress has been made.

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* Paper read before the Society of Arts, March 5th, 1884.

The tendency of recent improvements has been to improve the mechanical details, and to increase the out-put of the smaller machines. Thus by increasing the quantity and quality of iron, by better winding, and by rearranging some parts of the machines, Dr. Hopkinson has succeeded in doubling the out-put of the Edison dynamo. Mr. Crompton, by somewhat similar means, and by using the purest iron obtainable, has succeeded in making his Bürgin dynamo light up 210 lamps, instead of 90. Sir William Thomson and Mr. Ferranti have turned out a little machine which succeeds in lighting up 1,000 lamps by a mass of metal, which two years ago would not have illuminated 100 similar lamps.

Thus we have a process which is still actively going on, by which the economical out-put of a given weight of material is vastly increased.

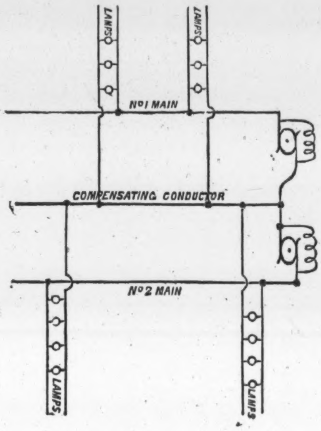
One of the most interesting objects at the Fisheries Exhibition last year was the Hochhausen dynamo, which is one of the most remarkable yet brought into the market. Those who visit the forthcoming Health Exhibition will have an opportunity of inspecting it. The main features of this dynamo are the extreme simplicity and the mechanical accuracy of its parts, the automatic mode of governing, its great adaptability, so that it can be varied at will either to high or low tension, and the remarkably low velocity for such high electro-motive force.

The distribution of the currents through conductors is one of the problems that demands the highest skill of the engineer, not alone for the efficient working of the system, but for its economy. It is not sufficient to convert our useful energy into electric currents, we want to distribute them with the least possible waste. Conduction means waste, and this waste can be controlled only by using the purest metal, and by so regulating the electromotive force and dimensions of the conductor as to obtain the maximum effect with the minimum means. It is an exceedingly difficult problem to solve. The metal universally used is copper, but very few people take the precaution to test its purity. Contractors go to the cheapest market, and the result is they get the nastiest material. I know of conductors that give only 70 per cent. of the conductivity that they should give. This means largely increased waste, and greatly enhanced cost of working. Impure copper not only means needless waste, but waste means heat, and therefore danger.

But wasted energy may also take the form of leakage, or direct loss of current. This is cured only by good insulation. Good insulation unfortunately means expense; and here again competition has forced too much economy. I have not examined one single case of the failure of an electric light that has not been traceable either to crass ignorance, or to needless economy. Perfectly well insulated copper conductors are within the reach of all who choose to pay for them; but when proper specification, proper inspection, and proper tests are neglected, we must expect, as has too often happened, failure and expense.

A marvellous improvement has been made by Dr. John Hopkinson and by Mr. Edison, independently of each other, by which the weight of copper necessary for central station working has been diminished 60 per cent., and this is due to the use of two dynamos connected in series, and a third, or compensating conductor, placed between them, as shown in the accompanying diagram. The weight of copper necessary for a conductor can also be diminished by the use of high tension currents, and this has led to various suggestions by which high tension currents shall be used for charging secondary batteries, and for exciting induction coils, but the use of high tension currents for household purposes is at present regarded as dangerous. High tension currents are, however, available for public street lighting, and are very satisfactorily employed for this purpose. There is a very senseless crusade being conducted just now in certain quarters against overhead wires. Overhead wires, if properly constructed, are most desirable, especially for electric lighting. It is the terrible abuse of this mode of construction that has caused the present onslaught upon them. Overhead wires can be made absolutely secure; they need not be a disfigurement nor an injury; they are far more readily maintained than underground wires; they facilitate the economy of electric lighting, not only by affording better conductors, but by radiating away the waste heat generated, and by requiring fewer joints and connecting points.

I do not in the least object to overhead wires through our streets for public lighting, though I strongly object to the cloud of wires that now obstruct the sky line in many of our thoroughfares. When ugly objects form an essential function of utility, it is wonderful how their unsightliness is condoned. Who complains of the ugliness of gas lamp-posts, and what is there in the necessary adjuncts of town life more ungraceful or hideous?



I do not, however, advocate overhead wires for general lighting. The conductors in that case must go underground, and with the great demand for telegraphs, telephones, and electric lighting, it is a pity that our corporations do not extend that useful system of subways, that has been partially carried out in the City of London, for easy fixing and inspection. The present mode of laying pipes in trenches is not only costly, but dangerous, and it has led to many more accidents than have been occasioned by the falling of overhead wires. Our streets are almost always open for either gas, water, telegraphs, or telephones, and the evil is increasing, and will continue to increase, with electric lighting. The cure is proper subways.

The progress made during the past two years in the form and character of lamps, whether arc or glow, has not been very marked. In arc lamps the tendency has been to simplify the working parts, and to increase their steadiness of action. The Crompton, Pilsen, and Fyfe-Main lamps leave little to be desired in this respect. At the Vienna Exhibition there was a remarkably steady lamp in the French Section, the Abdank lamp, but it has not been seen in England yet. The arc lamp has many serious defects, which circumscribe its value very considerably, but it is eminently adapted for workshops, railway goods yards, and for large spaces where high masts can be fixed.

For general domestic illumination the glow lamp, as made by Swan and Edison, is, in my opinion, the only proper one. At the Munich and Vienna Exhibitions, a remarkable lamp by Cruto, of Turin, was shown. It gave very good results, and absorbed a very small current, but it is not in the market yet. At Vienna the Bernstein lamp attracted much attention. It was a thin carbon tube made by carbonising a hollow silk ribbon, but it had low resistance, and required much current. It gave a considerably higher candle power than we are accustomed to. For instance, one lamp requiring 5 ampères and 30 volts, gave 60 candles; and another, with 8·5 ampères and 35 volts, gave 100 candles. Its normal efficiency of 2·5 watts per candle was very low, the efficiency of the Swan lamp being 3·5 watts per candle, and that of the Edison 4 watts per candle. Its duration is said to be very great. All glow lamps can be made to give economical results when we use large currents, but, unfortunately, their life is much curtailed by doing so. The filament is disintegrated, and the inside of the glass is, in consequence, covered with a dark deposit. Hence we are obliged to be satisfied with low efficiency to obtain reasonable durability.

The Bernstein lamp is, however, of an inconvenient power, and while it may do for street lighting, and for large spaces, it is not adapted, in its present form, for our rooms and offices. It is, therefore, a lamp that is more likely to replace arc lamps than the present glow lamps, as made by Edison and Swan. It has, however, shown us a direction in which economy can be effected, and we may reasonably hope that the workers in this field will soon find a means to improve the present efficiency of the small glow lamps, and thus reduce the cost of working them.

A good many private houses, as well as public establishments, have been recently fitted up, and their experience has developed many difficulties and dangers which have only to be found out to enable them to be overcome. There is no use ignoring the fact that the admission of electric currents into our homes means the admission of a new danger—a danger that is only to be surmounted by the dictates of experience. Careful rules and regulations have been drawn up for the guidance of those who are executing installations, but the true remedy is to employ none but skilful and experienced contractors, and to have premises properly inspected by recognised professional men. Under such guidance electric light leads can be made absolutely harmless and devoid of all danger. The same cannot be said of gas, oil, or candle, for they involve the use of matches, and are always in a condition of potential danger. 2,041 persons in England alone, in 1881, met with violent deaths from burns, scalds, and explosions (not in mines). In one week, not long ago, six deaths from explosions of gas were recorded in the *Times*. Hence, while electricity is certainly accompanied by its own dangers, these dangers can be neutralised, and other infinitely more serious ones can be completely expelled from our houses.

Mr. Killingworth Hedges has devoted a great deal of attention to safety catches, and he certainly has produced the most efficient that are in the market. No electric light lead should be without its safety plug or cut out. It is a precaution of a cheap and simple character, efficient, and reliable in action. A bar or sheet of lead, or alloy, is inserted in the circuit, which is instantly fused when from any cause the current exceeds its proper amount. It is a nuisance to be left in the dark, which must happen when the safety catch is fused, for the circuit is broken; but one can submit to this when the result is safety gained, or some source of danger eliminated. The remedy is a little barbarous, but it is efficient. A less crude contrivance was shown in Vienna—the invention of Mr. Anderson—but I have not seen it in practice.

It is most desirable that we should have, in every electric light installation, instruments to measure the current flowing and the electric pressure present. Ammeters, or current measures, and voltmeters, or pressure indicators, are very numerous.

Another important economical feature is the proper distribution of light, and Trotter's dioptric system is very ingenious and useful.

I scarcely think that the true solution of isolated house lighting will be secured until we can obtain reliable, effective, and economical secondary batteries. Planté's original accumulator, as improved by Faure, Sellon, and Volckmar, has not yet reached that stage of perfection that one would wish to see, but the progress towards this desideratum is steady and promising. Planté has himself made a decided improvement by preparing his lead plates in nitric acid, and the experiments that I have made with his cells, as supplied by Elwell and Parker, of Wolverhampton, are so encouraging that I am about to use a set of them in my own house. A secondary battery has this advantage, that your electricity is stored up to be used when you want it, by day or night, without the constant use of machinery. In ordinary houses, such as mine, there ought not to be required more than one day a week for charging—a day set apart for the purpose like washing day—when sufficient electricity should be stored up for a week's work. I scarcely hope to do this yet, but it is well within the bounds of possibility.

I have indicated to you the direction in which progress has been made. The output of the apparatus has been greatly increased, and, therefore, the capital required for installation reduced, the expenditure on conductors has been considerably diminished, the efficiency of the lamps—especially in their durability—has been improved, and all these steps in advance have the tendency to economise the production of the electric light. But the progress is being continued, and there is vast room for this improvement. Nothing approaching finality has yet been reached.

I see no reason whatever why our public streets should not be as efficiently lighted by electricity as they are now by gas, and for the same price. But the public are not satisfied with the same illumination; they will have more light. They are spoilt by the dazzling splendour of the arc lamp, and they treat with contempt the less showy glow lamp. Nevertheless, the best lighted street in the City of London is the Holborn Viaduct. The Thames Embankment and Waterloo Bridge have now been lighted by 50 arc lamps for over five years by the Jablochkoff Company. Blackfriars Bridge, Bridge Street, Ludgate Hill, St. Paul's Churchyard, and Cheapside have been lighted by 38 Brush arc lamps for three years. We are now engaged in a very interesting series of experiments at Wimbledon, to determine the best and most efficient way of lighting public streets, and much value in an economical sense will, it is hoped, accrue from these trials.

It is remarkable how the use of electricity is growing in favour with theatre managers. Supported by the success of the Savoy, the Criterion, and the new Prince's Theatre in London, the Prince's Theatre in Manchester, the Prince of Wales and the Royal Theatres in Birmingham, two theatres in Glasgow, and many others, are following Mr. D'Oyley Carte's spirited venture, and who can refrain from wishing that all would follow his example? Cool and pure air, absence of headache, and cheerfulness of mind are experienced at the Savoy, while the reverse is felt elsewhere where gas is used. I have recently examined the estimates for lighting up the Opera House in Vienna, and I have every reason to believe that less than 30s. per lamp per annum will brilliantly illuminate that beautiful house, and give a handsome return to those who have undertaken the contract.

There are many small central stations at work in England, but none on a large scale. At New York there are several. The Edison Company's first station lights 431 houses, and 10,300 lamps, and they are now erecting two new ones for 50,000 and 70,000 lamps respectively. We have in London one at work on the Holborn Viaduct, another at Brixton, and another for 5,700 lamps will shortly by opened at Victoria Station. There are small central stations at Godalming, Chesterfield, and Colchester. The Hammond Company have one at Brighton, which works over an area of seven miles. This company maintains 900 arc lamps and 5,500 glow lamps in different places in England. There is a central station at the Edgware Road Station of the Metropolitan Railway, whence Notting Hill Gate, Gower Street, King's Cross, and Aldgate Stations are lighted over a length of 15 miles long. 151 glow and five arc lamps are illuminated by the distributing system of Gaulard and Gibbs. Lord Salisbury, an amateur electrician of no mean type, has established quite a system of his own at Hatfield. The *Times*, ever in the van of progress, has for four years lighted up its printing and compositors' room.

Our new Law Courts are admirably lighted, and some of the judges have said that the electric light is the only good thing in this new Palace of Justice. The House of Commons has gradually been fitted up, and the Colonial Parliament Houses in Cape Town and New South Wales are following the examples. Indeed, restaurants, hotels, and public buildings are all testifying to the fact that I am so anxious to bring before you, that electric lighting is a decided success, for they are using it. But we want to see it in our homes. An excellent little book on this point has recently been published by Mr. Hammond, which is well worth your perusal. He has given there a table so striking and convincing that I have had it copied and suspended for your information:—

The following table shows the oxygen consumed, the carbonic acid produced, and the air vitiated by the combustion of certain bodies burnt so as to give the light of 12 standard sperm candles, each candle burning at the rate of 120 grains per hour:—

Burnt to give light of 12 candles, equal to 120 grs. per hour.	Cubic feet of oxygen consumed.	Cubic feet of air consumed.	Cubic feet of carbonic acid produced.	Cubic feet of air vitiated.	Heat produced in lbs. of water raised 10° F.
Cannel Gas ...	3·30	16·50	2·01	217·50	195·0
Common Gas ...	5·45	17·25	3·21	348·25	278·6
Sperm Oil	4·75	23·75	3·33	356·75	233·5
Bensole	4·45	22·30	3·54	376·30	232·6
Paraffin	6·81	34·05	4·50	484·05	361·9
Camphine	6·65	33·25	4·77	510·25	325·1
Sperm Candles ...	7·57	37·85	5·77	614·85	351·7
Wax	8·41	42·05	5·90	632·25	383·1
Stearic	8·82	44·10	6·25	669·10	374·7
Tallow	12·00	60·00	8·73	933·00	305·4
Electric Light ...	none	none	none	none	13·8

There you see why the electric light is so pure and so healthy. There is no consumption or pollution of air. There is the smallest possible production of heat. There are none of the existing dangers from fire or suffocation, but all is pure, healthy, and safe.

Our homes on the sea—those ocean palaces that render voyages to America and our colonies a pleasant yachting picnic—are being gradually fitted. Over 60 are already so fitted, and all will soon be done. None but those who have tumbled and tossed on the angry ocean in a pitch-dark confined crib for the seemingly never-ending night, can appreciate the peace and comfort of the soft and gentle little glow-lamp that is now supplied.

Efforts are being made to introduce primary batteries for the generation of electric-light currents, but not as yet with marked success. Unless the products of combustion can be sold profitably, primary batteries must necessarily be costly, and their constant renewal, and the amount of personal supervision they demand, militates much against their use, but some admirable batteries for small and temporary installations have been brought out, notably that of Mr. Holmes. Our railway trains are being lighted. Very satisfactory experiments are being made on the Brighton, South Western, South Eastern, Metropolitan, Midland, and Great Northern Railways, with dynamos, primary and secondary batteries, and there is no doubt whatever of their ultimate success. There is no reason why the energy of the moving train itself should not produce currents of electricity to illuminate every compartment with the light of day.

Exhibitions have been both banes and antidotes. They have had much to do with the cause of the late mania, but they have also encouraged invention, and stirred up emulation. Last year's Fisheries Exhibition did much to educate Londoners to the advantages of the light. This year's Health Exhibition will do more; and I venture to prophecy—a foolish practice, unless you know—that this Exhibition will, as an electric light display, be the best we have ever seen.

There have been a good many failures in electric lighting, as there must be in the introduction of every new enterprise, but every failure can be traced to imperfect apparatus, or to the employment of inexperienced contractors—in fact, to bad engineering. It is not long since that the wiring of a large building was let to one firm, and the lighting to another, with the necessary consequence that the whole thing "burst up," to use an Americanism, on the night of opening.

It is difficult to express any opinion on the economy of the electric light. We have not had the experience of any central lighting station of sufficient magnitude to justify the formation of such opinion. Any comparison between gas and electricity on this basis is unfair, because gas is produced in quantities sufficient to supply hundreds of thousands of lamps, while the largest electric light station yet erected does not light up 10,000 lamps. In New York, the price is the same for electricity as for gas, but then gas costs 12s. per 1,000 cubic feet, as it did in London, in the memory, perhaps, of some present. Nevertheless, the cost of supplying electricity now is far less than was the cost of supplying gas in the early days of its introduction.

But why draw a comparison? People do not compare the cost of gas with that of candles, nor the price of a pheasant with that of a mutton chop. If we want a luxury we must pay for it, and if the price of the luxury is not too great, people will have it. People will have electric light, if it can be supplied to them, not because it is cheap, but because it is safe, healthy, pure, soft, and natural. And, moreover, they will not object to pay any reasonable price for it, whatever may be the price of gas. Gas is most destructive, unhealthy, and objectionable when used for artificial illumination. The proper function of gas is the production of heat, and we see in this room how this production of heat can be utilised to form electric currents which diffuse about us a real luxury—pure light. When the electric light can be supplied, questions of sanitation, ventilation, and decoration will determine its use, and not questions of price. At present, for household purposes, it is a luxury for which we must pay; but the progress made is so rapid, and the room for improvement so great, that the day is not far distant when we shall cease to regard it as a luxury, and shall demand it as a necessity.

DISCUSSION.

The CHAIRMAN (Sir Frederick Abel, F.R.S.) said the paper had quite borne out his expectations, that it would show immense progress to have been made in electric lighting since Mr. Preece read a paper on the same subject some three years ago.

Mr. E. CROMPTON said he could not make a long speech, as he had been suffering all day from a bad headache, arising from a nine hours' argument with a recalcitrant Corporation committee, who seemed bent on putting wires into a public building of such a size as would have certainly set it on fire; and he was going back again by the 12 o'clock train to try and put the matter right. He would endeavour to say a word or two from his own experience; and first of all, with regard to the question of economy, he might say that in the minds of practical men there was no doubt whatever about the economy of the electric light. One point which Mr. Preece had forgotten to emphasise was, that in the future they must look less to electric systems and more to the men who carried them out. What had now to be done was the working out practically of the many inventions which had been brought out. Hitherto, the men had been kept in the background, and the systems put in front; but the gentlemen, such as he saw there, who had the foresight to gather around them a staff of young men, whom they had thoroughly trained in all the details of the science, were those who would carry electric lighting to a successful issue in the future. The reason why electric lighting spread so slowly in private houses was the almost insurmountable difficulty in finding a place to put the motive power. They had to put the machinery in cellars, and often part in one cellar and part in another, and the men in charge had to work underground—in fact, such difficulties were never thrown in the way of engineers before, owing to the enormous value of property in towns. These difficulties were so great, that it was wonderful the failures had not been more numerous, and very great credit was due to the sub-engineers—whose names never came forward —who worked out these details.

Mr. GEORGE OFFOR wished to correct one statement in the paper, with regard to licenses under the recent Act. A license for lighting the town of Colchester was being persevered in, and would be granted as soon as certain slight modifications had been arranged between Major Armstrong and the company. Again, with regard to the danger of distributing of electricity by currents of high tension, that had been got over at Colchester by the engineers in charge, in the following manner. Storage batteries were employed, which were charged in series from a central station by a high tension current; but to avoid the taking of that high tension current into the houses, each stack of batteries was divided into two parts, connected by a rocking switch, by means of which, while one-half the battery was being charged by the high tension current, the other half was in supply, and as soon as the electromotive force was reduced in the supply half to a certain point, it automatically threw the supply half into charge, and the charging half into supply. Under that arrangement, the potential carried into the houses was that of lamps used, and by that means the condition of the Board of Trade, that the potential should never exceed 200 volts, was complied with. With reference to the great question of economy, he could endorse all that Mr. Preece had said with regard to the readiness with which the electric light would be taken irrespective of the price of gas; but from his experience with a small installation of only 2,000 lamps, he found they could compete with gas at the same price.

Mr. HAMMOND said that the great obstacle was, in this case as in every other, that unless the best work was always put into it, any new thing took years to make its way. It was because every installation had not been a success that people who looked into it said they would wait a bit, and see what better could be done. As a man said to him the other day, he was at some place where all the lights went out. When Mr. Crompton had to spend nine hours in persuading people not to use wires which would burn the place down, they could understand the difficulties which had to be encountered. They had not yet recognised the fact that those who had to do this business must be men who never turn out bad work. He had had to suffer from this cause himself, having, as Mr. Preece had mentioned, to put machinery costing £5,000 to £6,000 into a building which had been fitted up with wires by people who had put up the electric bells. But better views were now beginning to prevail, and when it was generally recognised that good work had to be done in every direction, they would go a-head.

The CHAIRMAN said the discussion might usefully be continued to much greater length if time permitted, but unfortunately it did not. If time allowed him to go into the various uses of electric lighting, he should have had to mention several points which Mr. Preece had omitted; but he hoped that gentleman would bring the subject before them again at no very distant date, and give further details.

Mr. PREECE said, if he had one regret, it was that they had not had an opportunity of hearing something said from the gas companies' point of view. A very important point had been mentioned by Mr. Crompton, that they must look more to men than to systems, and Mr. Crompton himself was an example of the sort of men who were bringing electric lighting into the front rank. In preparing that paper he had visited Mr. Crompton's factory at Chelmsford, where 250 men were busily employed in the manufacture of these things; and he regretted that he had not been to Colchester, as he should not have made the mistake which Mr. Offor had corrected.

The CHAIRMAN, in proposing a vote of thanks to Mr. Preece, remarked that one important element in the development of every practical application of science was to find a clear exponent of the subject, who was at the same time honest enough to say frankly all he thought, either for or against the subject he was dealing with, and such a man they had in Mr. Preece.

TELEGRAPHISTS' CRAMP.

MR. THOMAS WEMYSS FULTON, formerly a telegraphist in the Edinburgh Post Office, now a distinguished medical student in the Edinburgh University, has contributed to *The Edinburgh Clinical and Pathological Journal* a paper on "Telegraphists' Cramp." "Trade palsy," says Mr. Fulton, "has long been known to the medical profession, but that telegraph operators were occasionally affected with a similar impotence was not generally known until 1875, when M. Onimus read a paper to the Société de Biologie on what he termed *mal télégraphique.* In this country it has been spoken of as "the rarest of medical curiosities," and as a rarity in comparison with other trade cramps; but, in reality, it is much more common than is supposed. As a matter of fact, telegraphists' cramp is relatively commoner than writers' cramp. I have seen four cases, and have had three described to me, while I have heard of only one case where a telegraph clerk was affected with *chorea scriptorum.*"

Mr. Fulton failed to find one single needle operator affected with cramp. Cable operators are never affected.

The manipulation of the Wheatstone perforator never produces the *mal télégraphique*, but when the left arm, which is used more than the right, begins to tire after prolonged exertion, some degree of inco-ordination is apt to appear, so that the discs are liable to be missed.

It is only in connection with the manipulation of the "Morse" that the crampy malady arises. From experiment Mr. Fulton calculates that an average operator makes between thirty and forty thousand flexor and extensor contractions per hour. The limitation of the ranges of movement, the great number of the contractions, their rapidity, difference of duration, and variability of succession, constitute the important and differential features of the Morse manipulation.

The writer holds that malco-ordination is the source of many telegraphic errors, and if it exists to a marked degree, it may unfit the operator for transmitting messages without the typical cramp being produced. Mr. Fulton traces fully the progress of the disease, and cites some very interesting cases, and concludes :—

"M. Onimus states that those of a nervous temperament—and, *ergo*, women—are especially prone to be affected; that the condition is accompanied by insomnia, palpitations, vertigo, and other subjective sensations; and that melancholia, loss of memory, moral and physical atony, and even insanity may supervene. English telegraphists may, however, derive comfort from the reflection that the mercurial disposition and more marked neurotic tendency of their gaelic *confrères* have a deal to do with the production of such disastrous results. Of the four cases I have seen, three were in young persons, of whom only one was a female, and another somewhat excitable; while the fourth, in whom the condition was most aggravated, was a robust man above 40, and with a temperament that would have done credit to a stoic. None were affected with any of the subjective sensations or mental disorder referred to by M. Onimus.

On the other hand, some individuals, excitable, and even hysterical, were quite exempt. The affection may seize upon the young clerk, or on one who has comparatively little manipulation to perform, while the older operator, or the one who does the greatest amount of work may escape. The condition is usually recovered from by merely abstaining from the manipulation, and this recovery may be complete, so that normal coordination may be regained in a year, or sooner; but the affection is liable to recur under prolonged strain.

THE GAULARD AND GIBBS SECONDARY GENERATORS.

WE have received a copy of Dr. Hopkinson's report on the efficiency of these induction coils, and we are pleased to note, from the tests made at Edgware Road, the comparatively small loss which takes place in the transformation. As is well known, we have, at various times, criticised Messrs. Gaulard and Gibbs' device somewhat severely; this, however, was not so much because we derived any satisfaction therefrom, but partly because it was imperative we should do so in the interests of any prior inventions of a like nature, and in part that the true practical value of the generators might be ascertained.

That we gladly welcome anything which is likely to give a genuine impetus to electric lighting we need scarcely insist upon, and we now take the opportunity of congratulating the inventors of the secondary generators on the very practical results, so far as these tests show, which they have obtained. Dr. Hopkinson's figures however, are a trifle too vague to allow of much criticism, and it is to be regretted that he assumes so much. To admit that from the tests on one coil the rest are doing equal or more work, is about as safe an estimate as to assume that because one house is lighted with 10 gas jets, burning a given quantity of gas, the remaining houses in the same street are likewise so illuminated. The Doctor is also somewhat contradictory in his remarks, anent the electrometer and electro-dynamometer methods of testing. In the beginning of the report he states that the former method is free from the undoubted theoretical objections to the use of the electro-dynamometer, but later on he makes the somewhat odd remark that the measurements with a Siemens electro-dynamometer agreed well with the electrometer measurements.

It would be interesting to know whether Dr. Hopkinson could show practically that his theoretical objections to the electro-dynamometer are well founded; indeed, it would not cause us any surprise if, upon reconsideration, he does not come to the conclusion that such objections are non-existant. We should be greatly pleased to see more exhaustive tests made to verify those of Dr. Hopkinson, for if the loss in the apparatus of Messrs. Gaulard and Gibbs is not more than 15 to 20 per cent., it may reasonably be expected that the secondary generators will command an extensive employment. Unfortunately, however, it appears from a comparison of the tests with, and without Jablochkoff candles, the percentage of loss in the incandescent lamp circuit is reduced in the first case to a considerable degree; in other words, it looks as if the secondary generators get less and less economical as the number of columns in use increase. To enable us to come to a just conclusion as to the *real* value of these coils, it is necessary that the details of the totals should be at hand.

Dr. Hopkinson's figures will be found embodied in the following report:

4, Westminster Chambers, Victoria Street, S.W.,
March 14th, 1884.

To the National Company for the Distribution of Electricity by Secondary Generators, Limited, 18, Warwick Street, Regent Street, W.

Gentlemen,—Having tested the instruments which I used in the experiments made at Edgware Road on the 11th and 12th inst., I am in a position to give you the precise results which they indicate.

The measurements were made with a Thomson's quadrant electrometer by the methods first used some years ago by M. Joubert in Paris. The constant of the instrument was determined in my laboratory, and was based upon Clark's standard cell. This method is free from the undoubted theoretical objections to the use of the electro-dynamometer for determining alternating differences of potential, or work done by alternating currents.

On the 11th instant the whole electrical power developed by the Siemens alternating current machine was determined by six readings of the electrometer, agreeing, with each other to be 16,710 Watts.

The secondary generator, in constant use for lighting the Edgware Road station, was also tested. This secondary generator consists of 16 columns, 12 of which were in actual use, no current being taken from the other four; eight were devoted to lighting 27 incandescent lamps, and four to two Jablochkoff candles.

During a portion of the time the Jablochkoff candles were extinguished, in order to enable me to determine the efficiency of the part devoted to the incandescent lights.

It was noted that when one part alone of the apparatus was in action considerable electrical disturbance took place in the unemployed columns, which would be prejudicial to the economical return of the secondary generator. This being a mere matter of adjustment which may be effected in a few moments, is of little consequence. The results, however, were as follows:—

	Watts.
Jablochkoff candles lighted—	
Work applied to primary between terminals...	2,767
Work delivered from terminals to incandescent lamp circuit	1,459
Jablochkoff candles cut out—	
Work applied to primary between terminals...	2,131
Work delivered from terminals to incandescent lamp circuit	1,689

Showing an efficiency of 79·3 per cent.

If we compare the electrical work actually developed by the Siemens machine, and the number of lights lighted on the system and the resistance of the main line, it would appear that the average efficiency of the other secondary generators must be better than that at Edgware Road, which is explained by my preceding remark, all the columns of the secondary generators supplying the stations at Aldgate and King's Cross being in use. In effect, the total electrical work being, as I have stated above, 16,710 Watts may be accounted for thus:—

151 incandescent lamps × 63 Watts	= 9,513	Watts
5 Jablochkoff candles × 375 „	= 1,875	„
Resistance of main line 30 ohms Primary current 11 ampères	= 3,630	„
	15,018	„

Giving an efficiency of secondary generator 89 per cent.

On the 12th instant a small secondary generator, a recent invention of Messrs. Gaulard & Gibbs, was tested. The simplicity of construction of this apparatus is remarkable. The secondary circuit was closed upon a resistance of German silver wire, reported to me to be 1·8 ohms, but which I find to be 1·9 ohms. The results obtained were:—

	Watts.
Work applied to primary between terminals ...	230
Work delivered from terminals to German Silver resistance	198

Giving an efficiency of 86·1 per cent.

As a check upon my results, a Siemens electro-dynamometer was introduced into the secondary circuit, and the current through the same resistance was measured 10·3 ampères, equivalent to 201·4 Watts, a result agreeing well with the electrometer measurements, considering the great difference between the principles of the two methods of measurement. The amount of work absorbed and delivered by this generator was small, but I have very little doubt that this is simply due to the resistance interposed in the secondary circuit being much too small, and I would recommend that some experiments be tried with other resistances; the measurements could easily be made with the Siemens electro-dynamometer any evening if you will have the following resistances prepared—30, 20, 10 and 5 ohms.

I am, Gentlemen, yours truly,
(Signed) J. HOPKINSON.

Telegraph Clerks in Dublin.—Mr. O'Brien asked the Postmaster-General on Thursday, whether he could see his way to acceding to the application of the telegraph clerks transferred to Dublin since Mr. Scudamore's scheme and engaged on Sunday and night duty, to be placed on an equality with their brother clerks previously in Dublin, in regard to the term of their annual leave of absence. Mr. Fawcett said, the question of annual leave was about to be carefully examined, and until this was done he was unable to say what decision might be arrived at in the case of the clerks referred to.

THE ELECTRICAL TRANSMISSION AND DISTRIBUTION OF ENERGY.*

By MARCEL DEPREZ.

* Translated from *La Lumière Electrique.*

(*Continued from page* 237.)

Limits of Unpriming.

We have thus the means of representing graphically the quantity, I_x, which it is required to render constant.

A simple construction enables us, by means of the characteristic, to determine in this new arrangement the point of unpriming. It is merely necessary to draw O L tangentially to the characteristic at its origin to meet the line, $y = (a + b)\,x + a\,b$, at L, and to let fall the line, L M; O M will be the resistance sought for.

Constant External Intensity.

As we have previously done, let us assimilate the characteristic to a right line, and by means of a separate current let us create an initial magnetic field, so that the characteristic may be represented by a right line cutting the axis of y (fig. 13).

Draw the line, $y = (a + b)\,x + a\,b$, which is defined by the data of the construction of the machine. By the process which we have given above we may determine a speed of the machine, such that its characteristic may be parallel to the right line, $y = (a + b)\,x + a\,b$.

The result obtained is represented in fig. 13. C B is the line, $y = (a + b)\,x + a\,b$; N F is the characteristic rendered parallel. Let us seek the intensity for a known external resistance, x.

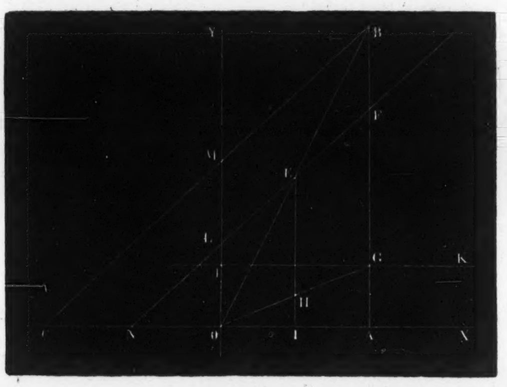


FIG. 13.

We take O J = b; we draw the line, J K, parallel to the axis of x Take O A = x, erect the ordinate, B A, as far as the right line, C B; at the point, B, join O B, this right line meets the characteristic in E; let fall E I, join O G, according to which we demonstrate that I H = I_x.

We have in the similar triangles—

$$\frac{IH}{AG} = \frac{CI}{AF} = \frac{OE}{OB} = \frac{OL}{OM},$$

but the last ratio is constant, therefore,

$$\frac{I_x}{b} = a$$

$$I_x = a\,b, \text{ the constant value.}$$

The process employed for determining the speed which the machine must have, so that its characteristic may have the desired inclination, is analogous to that which we have already used.

In the present case it is applied in the following manner :—

The right line, which determines the inclination to be obtained having for its equation $y = (a + b)\,x + a\,b$, its coefficient of inclination is $-(a + b)$. That of the former characteristic obtained with the velocity, V, and the current, I, being

$$\frac{E - E_0}{I}$$

as we have already explained, we must seek a velocity, V′, such that we have—

$$\frac{V'}{V} \cdot \frac{E - E_0}{I} = -(a + b);$$

then

$$V' = \frac{-(a + b)}{\frac{E - E_0}{I}},$$

but we here remark that $-(a + b)$ is merely the total resistance in the case where the inductors and the induced are connected in a single circuit, as in the ordinary arrangement. We have called this R in the foregoing theorems. We conclude, therefore, that in the two cases when it is required to maintain the difference of potential, or the intensity of the current constant, the velocity which the machine must receive is the same, the difference being in the method of connecting the inductor and induced circuits; the same apparatus can there give both results by the simple use of a commutator.

General Conclusion.

The totality of the theorems which have been explained comprises the complete study of the electric transmission and distribution of energy; they throw a light on the questions discussed, and give their solutions accurately and simply.

From their application, there follows a complete system which has been tried in proportions as yet limited, but nevertheless sufficient to confirm substantially the truth of these principles.

Complete experiments on a large scale will soon be conducted, and will succeed in showing the practical value of the procedures.

A certain number of special questions will naturally be solved in the course of this experimentation; many of them have been already entered upon. The graphic methods just exhibited will permit their solution. We may, *e.g.*, by the aid of the characteristic, examine the relation of two machines employed, the one as generator, the other as receiver, and all problems of this nature. It may be said in passing, that these procedures have a greater generality, and that by their means we may study any generating apparatus whatever, such as batteries, and find the laws of their action.

Besides questions of a more purely theoretical, we are concerned about practical resources, and have foreseen the employment of certain accessory appliances. Among these may be included accumulators; the author has long ago indicated their probable utility in distribution, and he will specify more precisely the part which they should play, and the special functions which they are destined to fulfil.

I do not in any manner conceal the obstacles which will present themselves, and which cannot be foreseen; but I know that difficulties of this kind are certain to be conquered if we take our stand upon principles firmly established. The geometrical rigour of the demonstrations given above permits us to be certain that the foundations of the system are mathematically secure; a very early experiment will supply the material proof.

Experimental Studies on Dynamo-electric Machines.

The theoretical considerations which have have just been reproduced, and which were first expounded in *La Lumière Electrique*, for Dec. 3rd 1881, and especially the graphic representation of those effects of the generating machines which I named "characteristics," have been the starting points of very extended experimental researches. I have applied these methods of examination to various types of machines under very varied conditions as to velocity and circuit.

These results, and the consequences which I have deduced from them, constitute a complete study on the dynamic generators of electricity. Without, however, waiting for the completion of this investigation, I believe it will be useful to give in a separate form some of the characteristic curves which have been established.

Experiments have been undertaken with the following types:

1. Gramme machines.
    - Small machine for galvano-plastic.
    - Type A. so-called "workshop."
    - Type A, strengthened.
    - Large galvano-plastic machine, Type D.
2. Siemens machines, D_0, D_1, D_2, D_3 and D_5.
3. Small Brush machine.
4. Machine on Pacinotti's plan embracing new arrangements to which I have been led by theoretical considerations which, as will be seen below, have received the most brilliant confirmation, since I have succeeded in causing work exceeding 20-horse power to be absorbed by a small machine the acting parts of which weigh only 130 kilos.
5. Gramme machine, the wires of which have been removed with the substitution of others of a much smaller diameter in order to obtain a very high electromotive force. The models which have been thus transformed are the small galvano-plastic, and the types A and E. I have thus succeeded in causing the machine A to produce the electromotive force of 2,400 volts, *i.e.*, more than 20 times the tension of ordinary machines of this type without any inconvenient results, in spite of the pessimist assertions and predictions of certain practitioners who pretend that in accordance with their personal experience so high tensions cannot be obtained and that if they were obtained the wires and the collectors would be rapidly destroyed. Experience has formally refuted all these assertions.

The subjoined characteristic curves have been obtained by closing the circuit of the machine experimented upon by wire of less and less resistance, so as gradually to increase the intensity of the current.

This intensity was measured with the Deprez galvanometer.

If we call this intensity I, the resistance of the machine at rest r, the external resistance R, and the electromotive force of the machine E, then $E = (R + r)\,I$. This formula shows the useful electromotive force, a deduction having been made of the effects due to the extra-currents produced in the section of the ring at the moment when the plates of the collector which correspond to them come in contact with the brushes; these extra-currents give rise to an inverse electromotive force.

Taking as abscissæ the successive intensities of the current, and as ordinates the product (R + r) I, we obtain a series of points which, as may be seen, follow each other with a regularity much greater than in the specimens of curves of the same kind previously obtained by M. Froehlich (see *La Lumière Electrique* for July 6th, 1881).

By constructing the curve which passes through all these points in the most satisfactory manner possible, we reduce to the smallest possible limit the small accidental errors which cannot entirely be avoided. We may employ the currents thus obtained for constructing tables much more accurate than those obtained with formulæ of interpolation of an arbitrary form. By this process the following tables which accompany the curves have been drawn up.

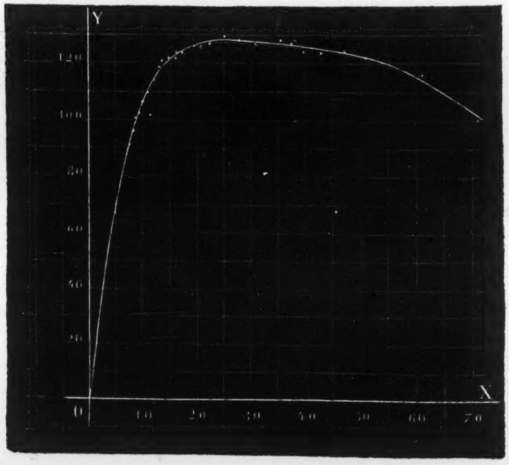
Curve No. 9. Jan. 24th, 1882.

CHARACTERISTIC OF GRAMME MACHINE A

(*Ordinary workshop type*).

At the Velocity of 1,440 Revolutions.

Intensity in ampères.	Electro-motive force in volts.	Intensity in ampères.	Electro-motive force in volts.	OBSERVATIONS.
5	72	40	127	Weight of the machine, 210 kilos.
10	107	45	125	
15	122	50	123	Resistance of ring............ 0·410
20	127	55	120	„ inductors ... 0·610
25	129	60	116	
30	128	65	110	„ total .... 1·020
35	128	70	101	



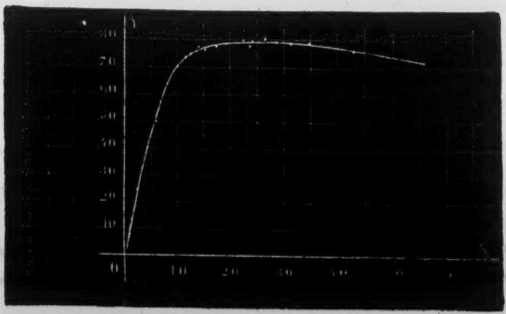
Curve No. 10. Jan. 25th, 1882.

CHARACTERISTIC OF MACHINE, TYPE A

(*Ordinary workshop type*).

At the Velocity of 950 Revolutions.

Intensity in ampères.	Electro-motive force in volts,	Intensity in ampères.	Electro-motive force in volts.	OBSERVATIONS.
5	45	35	79	Weight of machine ... 210 kilos.
10	70	40	78	
15	77	45	76	Resistance of ring .... 0·410
20	79	50	74	„ inductors ... 0·610
25	79	55	72	
30	79			„ total .... 1·020

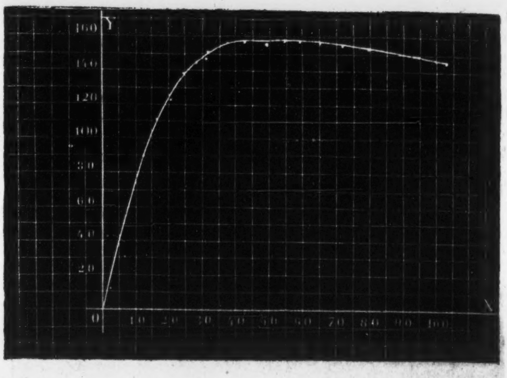


Curve No. 3. Jan. 22, 1882.

CHARACTERISTIC OF MACHINE, SIEMENS D_0.

At the Velocity of 670 Revolutions.

Intensity in ampères.	Electro-motive force in volts.	Intensity in ampères.	Electro-motive force in volts.	OBSERVATIONS.
5	37	60	157	Weight of machine ... 711 kilos.
10	73·5	65	157	
15	102	70	156	Resistance of ring .... 0·157
20	122·5	75	154	„ inductors ... 0·347
25	138	80	152·5	
30	146·5	85	150·5	„ total .... 0·504
35	152	90	149·5	
40	157	95	148	
45	157	100	147	
50	157	105	144	
55	157			

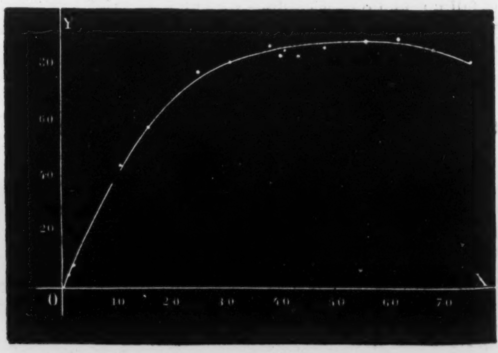


Curve No. 15. Dec. 9th, 1881.

CHARACTERISTIC OF MACHINE, SIEMENS D_1.

At the Velocity of 545 Revolutions.

Intensity in ampères.	Electro-motive force in volts.	Intensity in ampères.	Electro-motive force in volts.	OBSERVATIONS.
5	22	45	88·50	Weight of machine ... 550 kilos.
10	40	50	89·25	Wire of the ring... ... $4^{m}/_{m}$
15	55·75	55	89·75	„ inductors ...... $6{\cdot}5^{m}/_{m}$
20	68	60	89	
25	76·25	65	88	Resistance of ring .... 0·160
30	81·25	70	85	„ inductors ... 0·310
35	84·50	75	81·50	
40	86·75			„ total .... 0·470

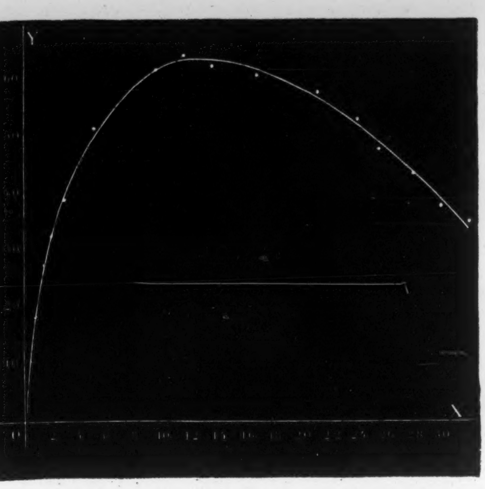


Curve No. 14. Dec. 3rd, 1881.

CHARACTERISTIC OF THE BRUSH MACHINE.

At the Velocity of 1,150 Revolutions.

Intensity in ampères.	Electro-motive force in volts.	Intensity in ampères.	Electro-motive force in volts.	OBSERVATIONS.
2	32·67	18	60·75	Internal resistance... 1·025 ohm.
4	45	20	58·50	
6	52·25	22	55·75	
8	58·50	24	52·50	
10	62·25	26	48·25	
12	63·50	28	43·75	
14	63·50	30	39	
16	62·50	32	34	



I shall not give the very numerous series of curves which have been found in the long series of experiments. I reproduce such only as appear to me suitable for showing important features.

The curves Nos. 9 and 10, with their tables are representative of the Gramme machine A, of the ordinary workshop model. It will be remarked that in conformity to the forecasts given in the theoretical studies already given, the characteristics rise almost in a right line. Only we are struck with the marked falling off of the electromotive force when the intensity becomes considerable.

This fact might have been surmised but could not be positively affirmed without experiment. We shall return in the sequel to the explanation which may be given and the remedies which may be applied for this defect.

This fault, however, is common to the machines at present in use, as it may be seen from the characteristics of the machines Siemens D_0, and D_1, No. 3 and No. 15, and especially for that of the Brush machine No. 14. In this last the falling off is excessive and marks a serious defect.

This peculiarity depends on the construction of the machines, for a change in the winding does not make it disappear as has been proved by experiments made with a Gramme machine of the type A, wrapped with a fine wire in order to be employed in the production of high tensions and applied to the electrical transmission of energy.

To detect the cause I performed a series of experiments, in which I studied separately the action of the two essential parts of the machine.

In the first series I kept the magnetic field of a Gramme machine constant, by exciting the inductors by means of an auxiliary source, and I examined how the electromotive force of the ring would vary, revolving always at the same speed, on closing the exterior circuit with smaller and smaller resistances.

Among other experiments, I give a series of results obtained Nov. 19th, 1881.

R	I	E	R	I	E
11·432	2·60	29·72	1·351	22·00	29·72
10·552	2·80	29·55	1·190	24·80	29·51
8·952	3·20	28·65	1·026	29·20	29·96
7·957	3·60	28·65	0·841	34·40	28·93
7·077	4·00	28·31	0·653	43·20	28·21
5·512	5·40	29·76	0·465	59·20	27·53
4·517	6·60	29·81	0·278	88·20	24·69
3·637	8·40	30·55	0·187	122·40	22·89
1·968	15·20	29·91	0·156	134·40	20·97
1·837	15·80	30·86	0·140	141·60	19·82
1·678	17·60	29·53	0·131	144·00	18·86
1·512	19·20	29·03	0·093	168·00	15·62

As from the characteristic of the machine I knew that the inductors were saturated from 35 ampères upwards, I excited them by means of a powerful auxiliary current of the intensity of about 80 ampères. I placed myself thus in the requisite conditions for obtaining the supersaturation of the inductors. The first column, R, indicates for each determination the sum of the resistance of the ring and of the external circuit; as will be seen these resistances vary within very wide limits; the experiments have been carried to the utmost. The second column, I, indicates the intensity of the current, and the third column, E, shows the electromotive force developed in the ring calculated according to Ohm's law E = R I, after the termination of the variable period.

The decline of the electromotive force for high intensities is very well marked.

The following table shows the decline of the electromotive force in a yet more striking manner. The experiments which it summarises have been made with a dynamo machine, the inductors of which were excited by a current of 10·5 ampères, very much inferior to what would be required for their saturation. We see that when the total resistance of the circuit falls from 1·775 ohm to 0·05 ohm, the intensity rises from 18·5 ampères to 8·4 ampères, whilst the electromotive force declines from 33 volts to 4·2 volts, almost in the ratio of 8 to 1 :—

R	I	E	R	I	E
1·775	18·55	32·93	0·751	34·2	25·68
1·595	19·60	31·26	0·595	40·8	24.28
1·431	22·05	31·55	0·434	48·6	21·09
1·248	24	29·95	0·288	58·8	16·93
1·066	27	28·78	0·132	76·8	10·14
0·909	30·6	27·82	0·050	84·0	4·20

In a second series of experiments, on the contrary, the current traversing the ring was left constant whilst the current which produces the magnetic field was varied.

These experiments were made with a machine of the Marcel Deprez model with two rings; one of the rings serves to excite the inductors, the power of the magnetic field being varied by means of the resistances.

The other ring sends its current into a recipient machine fitted with a Carpentier brake, in which there is preserved a constant charge. By this method there is the certainty of maintaining the current traversing the ring constant.

I	E	I	E
2	4·4	44	27·80
8	14·5	50	29
14	20·25	56	30·20
20	22·60	62	31·40
26	24·0	68	32·70
32	25·25	70	33·10
38	26·20		

We see that under these conditions the electromotive force increases continually, which gives a counter-test, confirming the results of the former experiments.

These results taken together demonstrate decisively that the decline noticed in the characteristics as soon as the current reached a high intensity, depends on the insufficiency of the inductors. These can, indeed, never be too powerful, which is an additional argument in favour, for I have proved both theoretically and experimentally, that a magnetic field of any given intensity is the less costly to produce in proportion, as it is generated by electro-magnets of greater dimensions.

As for the cause of this phenomenon, I think that it may be explained thus :—

Suppose that we suppress the passage of the current into the inductors and allow it to pass into the ring only; this latter becomes a magnet, the line of the poles of which, *a′ b′*, coincides with the line which passes by the points of contact of the brushes and of the collector. If we execute an inverse operation, suppressing the current which traverses the ring, and re-establishing that in the inductors, the new line, *a b*, of the poles of the ring, will coincide with the line of the inductors. Hence it results that, when the current traverses at once both the ring and the inductors, the line, A B, of the poles of the ring occupies a position intermediate between the two extreme positions just defined, and which may be determined by a construction identical with that

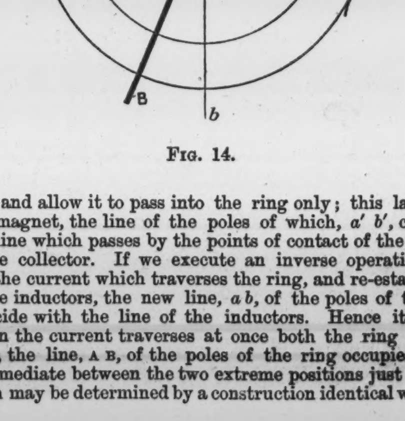


FIG. 14.

of the parallelogram of forces; O F, representing the magnetisation due to the influence of the inductors, and O F′, that due to the passage of the current around the ring, the diagonal, O A, will represent the true magnetisation of the ring. It is easy to see how much must be taken to determine the line of contact of the brushes, so that it may be perpendicular to O A, the magnitudes of O *f*, and O *f*′, being known. We perceive from this problem that the magnetisation resulting from the ring is always smaller than that due to the inductors alone, and that, besides, a part of the poles of the inductors is found in opposition to a part of the ring having the same polarity, which causes the lines of force to deviate considerably from a direction normal to the ring, and weakens, consequently, the electromotive force.

The only means of diminishing within a certain limit this defect inherent in dynamo machines, consists in the employment of very powerful inductors and of brushes of a variable level.

These conclusions having been established, I modified the machines, and taking a Gramme machine I replaced its inductors by inductors much larger and more powerful.

They consisted of an ordinary simple electro-magnet of two branches ending in polar pieces inclosing the ring. This form then much resembled the original form adopted by Prof. Pacinotti. The polar pieces weighed 9 kilos. each, so that the weight of the cores and of the polar pieces was 54 kilos., and that of the inductor wire 36 kilos. This change was to show that with inductors sufficiently powerful there is no reason to fear the decline which the characteristic always undergoes in the ordinary types of machines, and which is bad from all points of view, as will be seen when we discuss the measurement of static efforts and their price.

A simple examination of the curve No. 25, shows that this object has been completely attained.

The curve No 26, has been obtained with the same machine, but its cast-metal polar pieces have been replaced by others of the same form of wrought iron. The intensity of the current reached the enormous figure of 260 ampères, without the electromotive force undergoing the slightest decrease, thanks to the grouping of the wires of the inductors. The purpose, therefore, has been effected.

The curve No. 27, refers to the same machine in which the grouping of the wires of the inductors has been re-established as in No. 25, but preserving the wrought-iron armatures and revolving 2,325 times per minute in place of 2,800.

Having thus shown in what direction the existing types of machines must be modified, I have been desirous of finding what will ensue when these types are enlarged and when we arrive at the construction of powerful machines, I have firstly approached this question from the theoretical side.

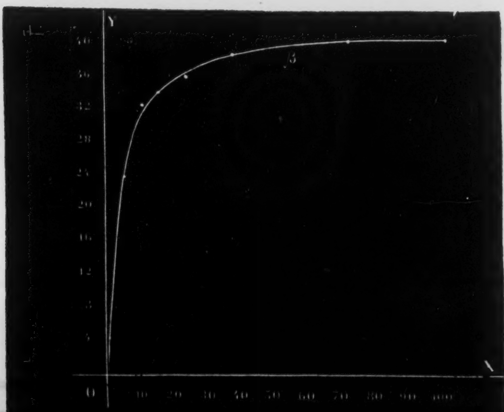
Curve No. 25. Jan. 7th, 1882.

CHARACTERISTIC OF THE MARCEL DEPREZ MACHINE.

(*Inductors strengthened; armatures of cast iron.*)

Velocity of 2,800 Revolutions.

I	E	I	E	OBSERVATIONS.
5	20	55	40·0	Weight of machine ... (?) kilos.
10	30	60	40·2	
15	33·6	65	40·4	Resistance of ring .... 0·040
20	35·4	70	40·4	„ inductors ... 0·175
25	36·8	75	40·5	
30	37·8	80	40·5	„ total .... 0·215
35	38·5	85	40·6	
40	39·2	90	40·7	
45	39·5	95	40·75	
50	39·7	100	40·8	



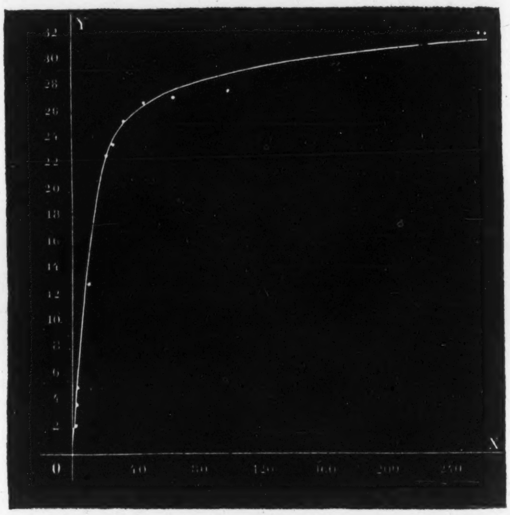
Curve No. 26. Jan. 13th, 1882.

CHARACTERISTIC OF THE MARCEL DEPREZ MACHINE.

(*Inductors strengthened; armatures of wrought iron*).

Velocity of 2,320 Revolutions.

I	E	I	E	OBSERVATIONS.
10	13·25	140	29·90	Weight of the machine (?) kilos.
20	21·25	150	30	
30	24·50	160	30·25	Resistance of ring .... 0·04
40	26·00	170	30·40	„ inductors in
50	27·00	180	30·50	quantity... 0·044
60	27·60	190	30·70	
70	28·00	200	30·75	„ total .... 0·084
80	28·13	210	30·90	
90	29·75	220	31	
100	29	230	31·13	
110	29·25	240	31·25	
120	29·50	250	31·31	
130	29·70	260	31·44	



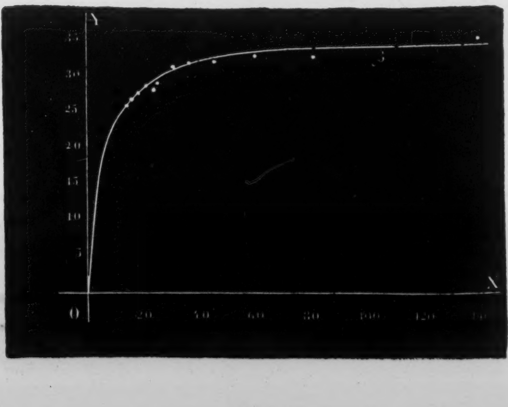
Curve No. 27. Jan. 13th, 1882.

CHARACTERISTIC OF THE MARCEL DEPREZ MACHINE.

(*Inductors strengthened; armatures of wrought iron*).

Velocity of 2,320 Revolutions.

I	E	I	E	OBSERVATIONS.
10	23·80	80	34·30	Weight of the machine (?) kilos.
20	28·40	90	34·40	
30	31	100	34·40	Resistance of ring .... 0·040
40	32·60	110	34·50	„ inductors in
50	33·40	120	34·60	series ...... 0·175
60	33·80	130	34·60	
70	34	140	34·60	„ total .... 0·215



It is not always easy, if we know the results developed under the influence of any agent in a system of known dimensions to foresee *a priori*, the effects to be produced in a system of different dimensions. In particular if the agent in question is heat the problem is very complex.

With electricity, on the contrary, the solution may be very simply reached in the following manner:

"If we increase all the dimensions of a conductive system of whatever form, according to a determined proportion K, without changing the electric current which traverses the unit section of the wire, the resultants of all the elementary static efforts increase as the fourth power of K.

Let us call I the intensity of the current traversing the conductive system and a the section of its wire. If we consider the elementary effort, dF, exerted between two elements of the conductive system of the length, ds and ds', if r is the distance separating these two elements and α the angle which they form with each other, then, applying the laws of Ampère

$dF = I^2 \frac{ds\,ds'}{r^2} f(\alpha)$ which we may also write

$$dF = \frac{I^2}{\alpha'} \frac{a\,ds\,a\,ds'}{n^2} f(\alpha)$$

But $a\,ds$ is the volume, dv, of the first element considered and $a\,ds'$ the volume, dv, of the second.

$$\text{Therefore } dF = \frac{I^2}{a^2} \frac{dv\,dv'}{r^2} f(\alpha)$$

If we now increase all the dimensions of the conductive system in the proportion K, retaining the same wire, the volume of the first element becomes $K^3\,dv$, that of the second $K^3\,dv'$, and the distance between them $K\,r$. The angle, α, does not change. The new elementary effort

$$dF' = \frac{I^2}{a^2} \frac{K^3\,dv\,K^3\,dv'}{K^2\,r^2} f(\alpha) = \frac{I^2}{a^2} \frac{dv\,dv'}{r^2} f(\alpha) \times K^4.$$

But if we suppose that the same electric current traverses the unit section of the wire, $\frac{I}{\alpha}$ is constant. The ratio of the two elementary efforts is $\frac{dF'}{dF} = K^4$.

The elementary efforts dF' and dF being in a constant proportion, the resultants of these efforts are also in the same proportion, almost at a constant; but this constant is nul, since when I is nil, F and F' must be nil; therefore $\frac{F'}{F} = K^4$.

The resultants of the elementary efforts increase, therefore, as the fourth power of K.

In the case when the conductive system is a dynamo-electric machine, we know that the work per second is represented by $T = F \times V$. F is the resultant of all the elementary efforts, the point of application of this resultant being situate at the end of one arm of a lever the circumference of which, developed, has the length of one metre. V is the linear velocity of this point of application.

If we augment all the dimensions of the dynamo-machine in the proportion K, preserving the section of the wire unaltered, the resultant of its efforts becomes equal to $F \times K^4$, and the linear velocity of its point of application $= K \times V$.

The new work per second $T' = K^4\,F\,V = K^5\,T$.

The work per second increases, therefore, as the fifth power of the number K.

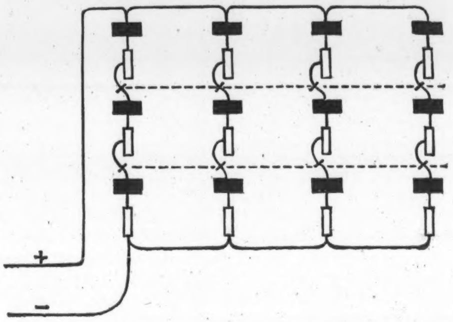
(In the above considerations it has been assumed that the dynamo-machine is not composed of soft iron.)

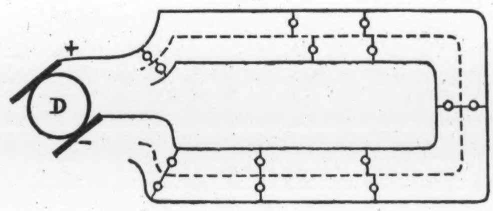
(To be continued.)

ELECTRIC LIGHT CONDUCTORS.

MR. W. H. PREECE, F.R.S., in his paper "On Recent Progress in Electric Lighting," which we publish this week, speaks of a marvellous improvement in electric lighting devised by Dr. John Hopkinson. It is unnecessary for us to reproduce, in this article, the details of that device. Suffice it to say that, by a method of connecting dynamo-electric machines, Dr. Hopkinson claims to effect a great saving in the cost of conductors. That such saving is a matter of the greatest importance is now apparent to everybody, but that the improvement to which we refer has anything of the marvellous in it we cannot admit. During the time of the late Richard Werdermann's experiments with his semi-incandescent lamps, which took place in 1878, public exhibitions of his system were very numerous. His lamps were first used in connection with an electro-plating Gramme machine of very low electromotive force. The machine and lamps (connected in parallel) were on the same floor, and the main wires were short lengths of about ½-inch diameter copper strand.

It was found that if the lamps were removed from the basement to the top of the building, the diminution in light was very striking, owing to the loss in the extra lengths of conductors. This loss led Mr. Robert Sabine, who was then the Managing Director to the Company in whose premises these experiments were carried on, to investigate the matter, and to connect up the lamps with a large Gramme arc light machine. The manner in which this was performed is clearly shown in the accompanying diagram.





With the higher electromotive force produced, the lamps were connected up between the main wires in series of twos or threes, as was found most convenient, the mains now being reduced in size to No. 12, B.W.G. Points of about the same potential between each set of lamps were joined together by smaller wires, as shown by the dotted lines. If one lamp of a series should go out, the remaining two, by the adoption of this method of connection, were not affected.

Mr. John Rapieff, also, in the same year, employed this mode of joining up his lamps, making that portion of wire (shown by the dotted lines) between each lamp of the same resistance as the lamp itself.

When fitting up an electric light installation on the ss. *Dacca*, some 14 months ago, Messrs. Wright and Mackie were, from force of circumstances, obliged to adopt a similar plan (see second diagram). The lamps employed by them were known as 80 volt lamps, but the machine supplied for producing the current gave an electromotive force just double that, or 160 volts. Between the main conductors, therefore, was led a third, shown in dotted lines, the lamps being connected as represented. Whether there is any advantage in using two machines of x volts each, with connections, as arranged by Dr. Hopkinson, over the employment of a single machine giving $2x$ volts with the connections as above, we leave others to decide. It appears to us, however, that so far as economy in conductors is concerned, the method of connecting up, which we have here described, may be made quite as efficient as the marvellous device which figures in Mr. Preece's excellent paper. Perhaps, however, from the brief details given therein, we may have formed a mistaken notion of the real character of the invention.

The late Comte du Moncel.—The will of the late Comte du Moncel includes a legacy of £600 to the Académie des Sciences, to be employed either in the foundation of a prize, the endowment of research, or for the pecuniary requirements of the Academy.

NOTES.

Electric Lighting.—At the annual general meeting of the proprietors of the Manchester Royal Exchange, held on the 19th inst., Mr. James Jardine, the chairman of the board of directors, made the following remarks respecting the electric light:—"It had been a great disappointment to the directors, and it must be also to the subscribers, that the light had disappeared for the time being, and when it was perhaps most important they should have a good light in the shortest days of winter. He might tell them, as some justification for the directors, that they entered into an arrangement with the British Electric Light Company some two years ago. The company undertook the entire responsibility of supplying the light to the room at a cost not exceeding the price they were paying for gas. The directors hardly expected they would be able to do that, because the electric light was what might be termed in its infancy. It was anticipated that the cost would be about £1,000, but the result was that the outlay proved to be something like £3,000. No sooner had the light been brought to that condition when they could look upon it with some satisfaction, than they received notice from the company of their intention to terminate the agreement. The directors were anxious to preserve the light if possible, and, after correspondence, made a proposition to pay double the price previously fixed upon if the company would continue to supply it. They were, however, met with a statement from the company that they were not prepared to do that, but that they would hand over the plant, and at the same time gave figures showing that the cost of producing the light was something like six or seven times more than that of gas. The directors could not, of course, undertake the responsibility of the machines, and in the meantime the plant was lying on the basement of the Exchange. What use would be made of it he did not know. The directors anticipated, and he believed, the time would come when the electric light would be produced at a less cost, and when that took place they would be the first to make such arrangements as were thought desirable to give the light to the Exchange Room."

Speaking of the coming Health Exhibition, the *Daily News* of Wednesday says:—"The electric lighting last year, as may be remembered, was a grand exposition of the science, but it will be better this time. There are already entered 22 exhibitors of the arc and incandescent system—350 lamps of the larger, and 5,000 of the smaller kind. An electrically-lighted clock is to be placed in the upper part of the grounds, where the big light on the tall mast used to stand." The same journal states that there is to be a wonderful fountain electrically illuminated at night.

The Commissioners of the International Health Exhibition, South Kensington, have contracted with W. T. Henley's Telegraph Works Company, Limited, for the supply of all the electric light cable they may require for the purposes of the exhibiton. Henley's patent Ozokerited India rubber insulation will be used.

Mr. Frederick D'A. Goold, of 29, Arcade Chambers, St. Mary's Gate, Manchester, having terminated his engagement with the Hammond Electric Light Company, is now engaged on his own account as an electrical engineer and contractor. The first work which he has undertaken is the lighting of Astley Bank, Darwin Lane, the residence of C. P. Huntington, Esq. The plant will consist of 100 60 V. incandescents, fed by a latest pattern "Victoria" dynamo.

On Tuesday evening the electric lighting of the Bethnal Green Museum by the Pilsen-Joel and General Electric Light Company was commenced. There are 24 Pilsen arc lamps, and 300 incandescence lamps employed. We hope that this may be continued successfully.

A public meeting of the inhabitants of Chesterfield, presided over by the mayor, was held on Monday evening, says the *Sheffield Daily Telegraph*, for the purpose of considering the question of the public lighting of the borough. The mayor said three years ago there was great dissatisfaction with the charges of the gas company, and, a dispute occurring, the streets were for a time in darkness. An attempt was made to light with oil, but this failing, electric lighting was resorted to, and had answered most efficiently, he believed, up to the present time. Mr. Warner contended that the electric light had been a failure, and had resulted in a number of accidents to traps belonging to him. He moved that the electric light was unsatisfactory, and that the serious consideration of the council was necessary with the view of substituting a better and cheaper means of illumination. Councillor Moffatt, in seconding this motion, said there were not half enough lamps. Mr. J. Gill moved an amendment, "That this meeting wishes to continue the use of the electric light, believing it to be better than gas, and that the mayor be requested to adjourn this meeting." The amendment, having been seconded by Dr. H. Robinson, who asserted that the electric light had succeeded most admirably, was eventually carried by an overwhelming majority.

The Goldstone Waterworks at Brighton have recently been extended by the addition of a large reservoir. The Waterworks Committee on Monday afternoon invited the members of the Corporation and other ladies and gentlemen interested, to an inspection of the new reservoir and cooling pond. The water by which the reservoir had been tested had been pumped out, and all who entered were able to explore its recesses with the greatest ease, as the committee had brought the electric light into use for the occasion and illuminated the structure by means of several large arc lights, as well as small incandescent lamps. Directions having been given, for the turning on of the water, the company in a few seconds witnessed the commencement of the filling of the reservoir. Just under the pipe were placed several incandescent lamps, which lit up the falling stream, and caused it to sparkle with great brilliancy. The sight was watched with much interest for some time, and eventually the company once more ascended to the daylight above, much pleased with their visit. The electric light installation was carried out by the British Electric Light Company.

Telephony.—The figures which we subjoin, says the *Pall Mall Gazette* of the 22nd inst., showing the number of messages sent through the United Telephone Company's London Exchange during the past week, are simply astounding, reaching as they do now to nearly 300,000 a week, or an increase of nearly 50,000 messages a week over the past month. Should this rapid rate of increase continue, this company will in the short period of four years from its formation be transmitting a greater number of messages than the whole Postal Telegraphs, not only in London, but in the United Kingdom.

			Calls.	Messages.	
Monday,	March	10,	25,497	50,994	Number of subscribers, 3,293, at £20 a year, = £1,267 for one week.
Tuesday,	,,	11,	25,658	51,316	
Wednesday,	,,	12,	25,335	50,670	
Thursday,	,,	13,	26,011	52,022	
Friday,	,,	14,	26,284	52,568	
Saturday,	,,	15,	17,074	34,148	
				291,718	for £1,267, or one penny per message.
Corresponding week in Feb.				249,202	
Increase				42,516	a week.

The wonderful wit and harrowing humour of the Bell monopoly's subsidised organ continues to be hurled at Drawbaugh. Arguments are useless against the conclusive evidence showing that Drawbaugh perfected a telephone years before Bell lays claim to the same invention, hence this resort to ridicule. The Drawbaugh "boom" has already served to reduce the price of Bell stock from 299 to 145. It has served to convince the public that the great monopoly is based upon nothing, and is doomed to destruction. It has exposed the weakness of a "ring" which endeavours, by bluster and brag, to maintain a power only used to enrich a favoured few; and it has clearly demonstrated that certain electrical organs dare not present well known facts to their readers. This the Drawbaugh "boom" has accomplished, and it is not done echoing yet.—*New York Economist.*

The Proposed Telephone Exchange for Portsmouth.—The result of the recent deputation from Portsmouth to the Postmaster General on the subject of the proposed telephone exchange was reported to the Chamber of Commerce of that town on Thursday last week. Mr. Alderman King, one of the deputation, having questioned the correctness of Mr. Fawcett's statements as to the success of the exchanges at Cardiff and Newcastle-on-Tyne, said if, as was suggested in a communication since received from the Postmaster-General, a man living a mile from the centre of an exchange would have to pay about £21 to become a subscriber, the number of such would be very small indeed in Portsmouth. The committee should point out, in replying to that communication, that unless arrangements were made for subscribers to belong to the exchange for £12, £13, or £14 a year, irrespective of their distance from the centre, the experiment was not likely to prove a success. The United Telephone Company, replying to a request from the committee concerned, to give their opinion upon the remarks of the Postmaster-General, complained that Mr. Fawcett had departed from the form of license settled at the time that the company's appeal was withdrawn, and refused to grant any licenses except upon terms which would enable not only the Postmaster-General, but also any person or company whom he chose to license to obtain the right to use the very valuable patent rights of Bell, Edison, and others, for which the United Company had paid large sums. It was eventually left to the committee to reply to Mr. Fawcett's communication, which they did to the effect that the rates quoted were prohibitory, and stating that they had ascertained that, excepting at Newcastle, the Post Office had not established any successful exchange in the country, Newcastle possessing special facilities for telephonic business. It was submitted whether it would not be equitable to charge a uniform rate to all subscribers within a certain radius, as it might frequently happen that the subscribers at the longest distance from the centre would be those who would derive least advantage; the radius suggested was a mile. The committee was of opinion that a charge of more than £15 would not secure sufficient subscribers to make the exchange a success.

The Lundy Cable.—The *Western Mail* (Cardiff) announced on Tuesday that the Lundy cable was successfully laid on Sunday last, and that the connections with the land lines would be completed in a few days. The cable was supplied by Mr. W. F. Rogers, of London, and is one of the thickest and most durable yet laid in this country. Its length is about 11 miles from the island to Hartland Point on the Devonshire coast, where the testing hut is situated on the summit of the cliff, about 200 feet above the sea level. The land lines from the point to Hartland Post Office, a distance of five miles, are of silicium bronze, and were erected by Mr. Legg, of Swansea. The Morse system of telegraphy will be adopted, and messages will be switched off direct to Exeter Post Office, which will be kept open all night for their reception. There seems to be some little soreness that the connection was not made with the Welsh coast instead of that of Devon, but the *Western Mail* says by the system proposed the messages will be sent in a direct and immediate manner, and will come round as quickly as if they were sent up the Welsh coast.

Telegraphic.—The Royal Engineers are engaged in fixing several additional telegraph wires along the route between London and Bristol, and a new telegraph service is to be established between the Metropolis and Exeter *viâ* Basingstoke and Salisbury Plain.

Telegraphic Communication with Eddystone Lighthouse.—The *Western Morning News* (Plymouth) of Wednesday last, says:—"The completion of the cable which will afford telegraphic communication between Lundy Island and the mainland, suggests the propriety of a strong effort being at once made to secure telegraphic communication between the Eddystone Lighthouse and the shore. This would be to shipping passing up and down the English Channel even more valuable than the Lundy cable will be to shipping in the Bristol Channel. The last attempts of the Plymouth Chamber of Commerce in this direction resulted in assurances from the Board of Trade, which encourage the hope that a further application now, backed by private enterprise, would be favourably entertained."

The Telegraph Steamer "Professor Morse."—We see that this veteran steamer has now reached another stage in her chequered career. She was built on the Clyde in 1866, by the Marine Investment Company, and intended for a blockade runner during the late Civil War in the United States, but hostilities having ceased before she was launched, she was converted from a paddle into a screw steamer. She made her debut as a collier, having been christened the *Aline.* She was bought in 1870 by Sir C. Bright, and fitted up as a cable ship; re-named the *Suffolk* and served during the laying of the West India Cables. She was then sold to the West India and Panama Company in 1872, and again bought from them by the Western Union Company in 1875, and once more changed her name, this time to *Professor Morse*; she has several times been used in repairing the International Ocean Telegraph Company's cables. She was sold again in 1883, and was running in the coal trade until she was wrecked lately in the Sound. The *New York Herald* states that she has once more changed hands and is at present in Delamater's Dock on the North River undergoing repairs and changes for the fruit trade.

The South African Telegraph.—The Eastern Telegraph Company notify that the Eastern and South African Company's cable between Mozambique and Delagoa Bay became interrupted on Thursday morning, about 50 miles from the latter place, in about 22 fathoms of water. The company's repairing ship is on the ground, and the cable is expected to be repaired promptly.

Munificent Telegraph Companies.—*The Colonies and India* learns that the Eastern Telegraph Company and the Eastern Extension Company, through Mr. John Pender, M.P., have subscribed £100 each towards the building fund of the Royal Colonial Institute. The names of Mr. Pender, Lord Tweeddale, Sir James Anderson, and Mr. Bevan, are down for election as Fellows of the Institute.

The Philadelphia Electrical Exhibition.—A telegram to the *Times* from Philadelphia, dated March 20, states that the Secretary of State has sent a circular to the American Diplomatic and Consular representatives, calling their attention to the International Electric Exhibition, to be held by the Franklin Institute at Philadelphia in September and October. Congress has passed a resolution recognising its advantages and probable useful results, and extending the privilege of free entry to all exhibits from abroad. The Secretary instructs the representatives to bring the project officially to the attention of the Governments to which they are respectively accredited; and also to make known the character, standing, and profession of the Exhibition.

Electricity and Water.—We have received a pamphlet entitled "Thoughts on the Inter-dependence of Water and Electricity and Cognate Subjects." The author says:—"It is perfectly clear to my mind that electricity, in combination with oxygen and hydrogen, are the *three* constituents of water." The two gases, he says, could not by themselves form a *fluid substance.* Water, continues our instructor, "can be produced by artificial means, simply by igniting a jet of hydrogen gas and suffering the flame to impinge on a cold surface, when the result will be water; but, during its formation it has, by some occult means, combined with a definite proportion of oxygen, taken from the atmosphere, but the two gases *only* would not form water." The author contends that, simultaneously with the absorption of oxygen, electricity from the atmosphere likewise entered with it, thus producing the well-known fluid substance, water. In the next paragraph he modestly states:—"I know next to nothing of chemistry, but I venture to assert that no chemist exists who could produce water from the two gases *only* by any *chemical* process." Further on we read that a simple method of obtaining a galvanic circle is to put a plate of zinc and one of platinum in a tumbler of pure water. When the plates are connected, we learn that *two* currents have been simultaneously produced, one going to the zinc, the other to the platinum; the plates acting only as exciters of the electricity of the water. If a more powerful battery be employed for the purpose of decomposition, the battery current is said to unite with the water's electricity and remove it at the same time that the gases are liberated. It would take up too much of our space to quote the bulk of this extraordinary production, but the author clinches his arguments by a reference to electrical eels. If electricity was not present in the water they inhabit, from what other source, says he, could they obtain a fresh supply. Mr. William Boggett concludes his work, which by the way we have read with as much zest as we experienced in perusing Mark Twain's "Jumping Frog," Bret Harte's "Heathen Chinee," and other humorous compilations, with the following profound observations:—"Early in the present century Count Rumford and other scientists made numerous experiments in order to determine whether or not caloric added weight to substances, and ultimately came to the conclusion that it did not. At present a like question may be interesting in respect to electricity, but its solution is a matter of no little difficulty. It has occurred to me, however, that it may possibly be solved in some of the following methods:—Firstly, by putting an induction coil into a glass scale, balancing it with weights in the opposite one, soldering the terminals of the secondary coil together, and passing a strong current through the primary, which would leave the secondary with a distinct charge, in order to learn if there was any increase of weight. Secondly, weighing a portion of lead previously prepared for storing electricity, and when charged re-weighing it, when an increase of weight must have proceeded from the electricity. Thirdly, weigh a portion of water previous to decomposing it, then weigh the decomposed water, to which add the weight of the gases. If the whole is less than the first weighing, the difference would be owing to the electricity lost by the water while being decomposed. Should the result of these experiments establish the fact of electricity being ponderable, it would be a great gain to science in future investigations, and probably lead to important discoveries. On the contrary, the absence of that knowledge would be no proof of the non-existence of electricity in water, seeing the difficulty, if not impossibility, of solving a problem of such an inscrutable nature." For the benefit of those of our readers who desire to procure a little light literature for the Easter holidays, we may add that the pamphlet is published by W. Ridgway, 169, Piccadilly, W. As an additional recommendation, it is worthy of notice that in 1842 our author wrote a treatise on the treatment of the *insane.*

Royal Meteorological Society.—The usual monthly meeting of this society was held on Wednesday evening, the 19th inst., at the Institution of Civil Engineers, Mr. R. H. Scott, F.R.S., President, in the chair. Messrs. W. Baily, M.A., W. L. Blore, A. L. Ford, H. Leupold, A. F. Lindemann, F.R.A.S., and Rev. E. B. Smith, were elected fellows of the society. The President read a paper entitled, "Brief Notes on the History of Thermometers," and then the meeting was adjourned, in order to afford the fellows and their friends an opportunity of inspecting the Exhibition of Thermometers and of Instruments recently invented. This Exhibition was a most interesting one, and embraced 136 exhibits. The thermometers were classified as follows:—(1) standard, (2) maximum, (3) minimum, (4) combined maximum and minimum, (5) metallic, (6) self-recording, (7) solar radiation, (8) sea, (9) earth and well, (10) thermometers used for special purposes, (11) thermometers with various forms of bulbs, scales, &c., and (12) miscellaneous thermometers. In addition to these there were also exhibited various patterns of thermometer screens, as well as several new meteorological instruments, together with drawings, photographs, &c.

Legal.—In the Court of Session at Edinburgh, on the 11th inst., the Jablochkoff Electric Light and Power Company, Limited, sued Messrs. Howard and Wyndham for payment of £1,732 5s. 4d., being the agreed price of an "installation" in the Lyceum Theatre, Edinburgh. Defenders explained that pursuers adopted an agreement which had been entered into between defenders and the Electric Carbon Storage and Apparatus Manufacturing Company of Scotland, Limited. By the agreement between defenders and the Carbon Company the price of the machinery and apparatus was fixed at £1,336, but payment was not to be made until 12 months after the opening of the theatre, and then bills were to be granted. The Carbon Company having gone into liquidation, the liquidator arranged with pursuers to adopt and carry out the agreement, and a communication was sent in their name agreeing to the arrangement. Defenders say that the working of the apparatus for electric lighting of the theatre has not given satisfaction, and the installation cannot be considered to be as yet complete. Defenders aver that they are willing to fulfil the whole obligations undertaken by them, and they intimate that on the defects being remedied they will grant bills. The case came up for the closing of the record, but this has been continued to allow pursuers to answer defendants' statements.

Central News Company v. Eastern Telegraph Company and Others.—An application was recently made at Chambers, and subsequently before Mr. Justice Field, for an order for the production by the defendants of certain cipher telegrams relating to the capture of Tel-el-Kebir, which they alleged were received previous to the message of plaintiffs, who contended that theirs was the first information of the capture, and that the intelligence having been distributed in London before the arrival of their telegram, therefore the latter had been delayed, and a similar message dispatched to the Exchange Telegraph Company, a company working in connection with the Eastern Telegraph Company. Both the Master in Chambers and Mr. Justice Field refused to make an order on the ground that the cipher telegrams did not appear to be relevant, and the plaintiffs appealed from that decision. The appeal came before the Lord Chief Justice and Mr. Justice Cave on Wednesday, Mr. Waddy, Q.C., and Mr. Dodd, appearing for the plaintiffs, and Mr. Moulton for the defendants. After a full discussion Lord Coleridge affirmed the decision given in Chambers, and, Mr. Justice Cave concurring, the appeal was dismissed.

The Victoria Engineers' Exhibition.—*The Colonies and India* states that the collection of electrical instruments at this exhibition has been increased by the addition of a number of novelties brought out by Mr. J. Widdicombe. Amongst them are a number of the most recent inventions in the way of electric bells, and a decided novelty in the shape of a diminutive pocket galvanic battery, the merit of which is great power, combined with simplicity of construction.

Electricity v. Gas.—At a special meeting of the Coventry City Council on Tuesday, Alderman Matterson brought forward a motion that it was expedient for the Council to promote a Bill to confirm and carry into effect an agreement for the purchase by the Corporation of the Coventry Gas Company. Mr. Andrews, in seconding, combated the theories of those who believed that gas would be shortly superseded by the electric light. Alderman Lynes moved an amendment that considering the progress of electric lighting it was inexpedient to burden ratepayers with the cost of the undertaking, which was stated at £168,000. After a long discussion the first resolution was carried by 21 votes to 2.

The Brighton Electric Railway.—A writer in the *World* has been remarking lately upon the electric railway at Brighton, and this week has the following: "Apropos of the electric railway at Brighton, I have received a letter from Mr. Volk, who states that he is not a German, but a born Brightonian; that neither his electric railway nor his lift will be objectionable; and that he is supported by some of the principal residents and owners of the districts. In reply to which I beg leave to state that this week a petition will be presented to the Town Council, signed by Sir A. Sassoon, Mr. J. Gray, and—except Mr. Ashbury, who is abroad—every inhabitant of Eastern terrace, on which the lift abuts, and by numerous and influential denizens of Sussex Square, Marine Parade, &c., praying that all permission given may be at once rescinded."

A Non-sparking Key.—A correspondent says:—I have noticed in your Journal a considerable amount of nonsense anent "non-sparking" keys and their effect upon the longevity of incandescence lamps, which effect Mr. A. Jamieson claims to have first observed. But alas! like the "telegraphing without wires," the "armatures made of copper ribbon" and the "secondary generators," the fact is a very old one; it was first observed by the late W. E. Sawyer, who devised an arrangement similar to that of Mr. Jamieson. The device is described in the REVIEW for 1877 or 1878, I cannot say which, as I have not the volumes. Full particulars will also be found in Sawyer's work on incandescent lighting. But the fact that the idea is old does not diminish the credit due to Messrs. Ayrton and Perry for their ingenious manner of carrying it out.

An Electric Tramway Incident.—The following appeared in the *Irish Times* (Dublin) on the 22nd inst.:—"It is not generally known that the country people along the line of the electric railway make strange uses of the insulated rails, which is the medium of the electricity on this tramway, in connection with one of which an extraordinary and very remarkable occurrence is reported. People have no objection to touch the rail and receive a smart shock, which is, however, harmless, at least so far. On Thursday evening a ploughman, returning from work, stood upon this rail in order to mount his horse. The rail is elevated on insulators 18 inches above the level of the tramway. As soon as the man placed his hands on the back of the animal it received a shock, which at once brought it down, and falling against the rail it died instantly. The remarkable part is, that the current of electricity which proved fatal to the brute must have passed through the body of the man and proved harmless to him."

Building Trades' Exhibition.—Messrs. G. Farmiloe & Sons, St. John Street, are displaying at this exhibition, opened on Monday at the Agricultural Hall, amongst other appliances, electric bells, &c. Mr. George Porter, 23, Cullum Street, Fenchurch Street, exhibited Porter's new patent electric bells, a new invention, of simple construction and slight cost.

The Gramme Patents.—The application of the British Electric Light Company for the prolongation of the term of the Gramme patents, which we recently announced was to come before the Judicial Committee of the Privy Council on Wednesday, the 2nd of April, is now, we learn, not to be proceeded with.

Lancashire Maxim-Weston Electric Co., Limited.—Notice is given in the *Gazette* for creditors of this company to send particulars of their claims to Thomas Whitworth and John Brown, the liquidators, 17, Warwick Street, Regent Street, W., on or before the 9th of April.

Maxim-Weston Electric Company, Limited.—This company's fully paid £1 shares were disposed of at 4s. 6d. at the sale of the Stock and Share Auction and Advance Company, on Thursday.

NEW COMPANY REGISTERED.

Whitehaven United Gas Company, Limited.—Capital £60,000 in £10 shares. Objects:—To acquire the business and property of the Whitehaven Gas Light Company, Limited, and, in addition to the business of a gas company, to carry on the business of an electric light company, and generally to supply electricity for light, heat, motive power, or other purposes. Signatories (with one share each)—*J. Hodgson, *J. H. Robinson. W. Hodgson, J. Robinson, A. Helder, J. Porter, all of Whitehaven, and H. Kenyon, of Carlisle. Directing qualification, £250 in shares or stock. The directors are Messrs. T. C. Dixon, W. Buryeat, jun., S. Studholme, and the two first signatories. Registered 22nd inst., by Mr. C. Doubble, of 14, Serjeant's Inn, Fleet Street, as agent for Messrs. Brockbank, Helder and Brockbank, Whitehaven.

OFFICIAL RETURNS OF ELECTRIC COMPANIES.

Railway Electrical Contractors, Limited.—An agreement dated 18th inst., was filed with the registered documents of this company on the 21st inst. The agreement is between Mr. T. M. Collet and the company, and relates to the purchase of the interest of the former in an invention of Messrs. Wm. Stroudley and Edward John Houghton, and also, (as far as possible), in the negotiations which he has been carrying on with the Electrical Power Storage Company, Limited; the Anglo-American Brush Electric Light Corporation, Limited, and Messrs. Cordner, Allen and Co. The consideration is the repayment to Mr. Collet of all sums expended by him in connection with the invention, and £15,000 in fully paid shares of the company.

Deal and Walmer Electric Light Company, Limited.—The registered office of this company is at No. 6, South Street, Deal, Kent.

Electric Portable Battery and Gas Igniting Company, Limited.—The annual return of this company, made up to the 13th inst. was filed on the 19th inst. The nominal capital is £100,000 in £5 shares. 16,000 shares have been taken up and fully paid, the paid-up capital thus being £5,370 in excess of the amount recorded in the previous return.

Anglo-Continental Telephone Company, Limited.—The annual return of this company made up to the 12th inst. was filed on the 20th inst. The nominal capital is £50,000 in £1 shares; 5,877 shares have been allotted, and the full amount has been called thereon, the calls paid amounting to £6,120, leaving £7 unpaid; £250 has been received by the company in respect of 900 shares forfeited. Since the registration of the previous return, the paid-up capital has increased £5,480.

United Telephone Company of the River Plate, Limited.—An agreement dated 17th inst. and filed with the documents of this company on the 18th, provides for the allotment to the London directors of 150 fully paid shares, in lieu of the sum of £375 due to them as directors' fees.

St. George Telephone Company, Limited.—An order of the High Court of Justice, Chancery Division, dated 12th of January, was filed with the documents of this company on the 18th inst., ordering the winding up of the company, upon the petition of Messrs. Edward James Paterson, and Charles Friend Cooper, of 76, Little Britain, Electric Light and Power and Telephone Engineers, creditors. It is also ordered that the costs of the petitioners and of the company be taxed by the Taxing Master, and paid out of the assets of the company.

PROCEEDINGS OF SOCIETIES.

Physical Society, March 22nd, 1884.

Prof. GUTHRIE, President, in the chair.

THE PRESIDENT announced that a meeting of the society would be held on May 10th at Birmingham, by invitation. The next meeting will be on April 26th.

Prof. S. P. THOMPSON then read a paper by himself and Mr. C. Starling on "Hall's phenomenon." The authors had not agreed with Hall's explanation of his observed effect, and last year undertook experiments to investigate its nature. They employed a strip of tinfoil, gummed on a mahogany board with vaseline, which, being soft and a non-conductor, answered well for this purpose. A top-shaped electro-magnet, with a pointed pole, was used on one side of the strip to try the effect of a pointed pole. The current was obtained from accumulators. They found that the equipotential lines in the strip, which before magnetisation ran straight across the strip, were slightly curved on either side of the pointed pole after magnetisation. This curving was interpreted as a reduction of resistance in the strip at the pole, and subsequent tests of the resistance of the strips in a magnetic field confirmed this view. Iron strips, however, showed a slight *increase* of resistance. It was also found that an effect similar to Hall's was got by placing the pointed pole so that this change of resistance was not symmetrical with respect to the points in the strip to which the galvanometer was connected. But inasmuch as this effect was not reversible by reversing the magnetism, it was not Hall's effect, which they failed to obtain with the narrow pointed pole. In their experiments thermo-electric effects were eliminated, and their results, though different, do not clash with those of Mr. Bidwell.

A paper by Mr. Herbert Tomlinson on the same subject was read by Prof. REINOLD. The author drew attention to a similarity between Hall's table of results and one of his on the effects of mechanical stress on electrical resistance.

Mr. SHELFORD BIDWELL read a note on "Hall's effect in tin," in which he showed that a small extension and a greater extension produced opposite thermo-electric effects in tin wires.

In answer to Prof. Guthrie and Mr. Walter Baily, Prof. THOMPSON stated that the change of resistance he had observed was sub-permanent, and died away in about half-an-hour; he believed it to be producible on the strip when no current traversed it.

Prof. S. P. THOMPSON then read a paper "On some propositions in electro-magnetics," giving a connected series of explanations throwing light on the laws of electro-magnetics, and based on a practical experiment.

CITY NOTES, REPORTS, MEETINGS, &c.

Direct Spanish Telegraph Company, Limited.

THE 21st ordinary general meeting of this company was held on Thursday, at the offices, Leadenhall Buildings, Mr. Bannatyne presiding.

The notice convening the meeting having been read,

The Chairman said the report (which we published last week) was so full that only a few remarks were now necessary. With regard to the expenditure, there had been increase in some items and decrease in others, the total decrease being £68 for the half year. They had been very unfortunate for some time past in having frequent interruptions of the cables. One had already been repaired, and the ship was on the way to repair another. The new cable for which they had contracted was nearly completed, only about 50 miles more having to be constructed, and it was confidently expected that the contractors would complete the laying of the cable in the early part of May, when it would at once be opened for traffic, and, it was hoped, put an end to the constant interruption of communication so detrimental to the interests of the company. The cost would be, as nearly as possible, £65,000, and that would be paid to the contractors in 6 per cent. debentures. He regretted that they had been for some time past unable to recommend a dividend on the ordinary shares, and expressed a hope that when the new cable was laid a fair amount would be earned for the ordinary shareholders. They had been prevented hitherto by the enormous cost of repairs; but he thought it was a matter now of congratulation that they had entered into a working agreement with the Eastern Telegraph Company, which would prevent their suffering so much from any interruption as they had hitherto done, and he was sure it was the desire of the Eastern Company to promote the interests of this undertaking. He concluded by moving the adoption of the report and accounts.

Mr. Etlinger seconded the motion.

Mr. Dyett asked whether it was proposed to issue any of the 6 per cent. debentures to the shareholders.

The Chairman replied that the whole would be required to pay the contractors. There was very little prospect of raising anything like the necessary amount by issuing those debentures to the shareholders or to the general public. It was the conviction of the directors, and of several shareholders, that it would not be possible to do so, and there was no alternative left but to enter into this arrangement with the contractors; they were glad to get the contract at the price they were to pay, it being one condition that payment should be taken in 6 per cent debentures, and this made the laying of the cable a certainty, which was what they wanted more than anything else. A new first-rate cable would put an end to the enormous expense of repairs, and bring about a state of things whereby they would be enabled to pay a fair dividend to the ordinary shareholders. Supposing the new cable were in full operation, their gross receipts, he thought, without being very sanguine, would average £24,000 a year. Replying to a shareholder, the chairman said it would be a question, when the new cable was laid, whether it would be a wise policy to expend any more money on the old cable; at any rate, in two or three years they would be in a better position to deal with the old cable if they thought it advisable to do so. Their traffic receipts for the present year had been, for January, £2,045; February, £1,567, and March, £1,905. If any shareholder wished to have any of those 6 per cent. debentures they must apply to the Construction Company and it was quite possible they might succeed in getting them. In reply to Mr. Cochran, he said the board, from what they knew at an earlier period, when there was a succession of breaks in the Bilbao cable, were satisfied that they got that cable on really advantageous terms, more so than they could have got from any other company, and they were highly satisfied when they accepted payment of the new cable in 6 per cent. debentures instead of cash.

Mr. B. Cochran remarked upon the steady and disproportionate advance in the expenses of the company, and said he doubted very much whether they would see the prosperous days predicted by the chairman.

The Chairman said he held out no exaggerated prospects; he simply said there was a fair prospect of a moderate dividend coming to the ordinary shareholders.

The adoption of the report was then unanimously carried.

The Chairman moved the declaration of a dividend of 10 per cent. per annum, less income tax, upon the preference shares.

Mr. Etlinger seconded the motion, which was carried.

Sir James Anderson moved the re-election of the retiring directors, Messrs. Bannatyne and Etlinger, which was seconded by Mr. J. D. Pender, and agreed to.

The auditor, Mr. H R. Duke, was re-elected on the motion of Mr. Dyett, seconded by Mr. Beard.

Mr. Cochran moved and Mr. Dyett seconded a vote of thanks to the board, which was carried and suitably acknowledged, after which the meeting terminated.

The "Pilsen-Joel" and General Electric Light Company, Limited.

ON Friday afternoon, the 21st inst., an extraordinary general meeting of this company was held at the offices, St. Stephen's Chambers, Telegraph Street, for the purpose of considering resolutions passed on the 6th inst., with a view to their confirmation. Sir Rawson W. Rawson, C.B., presided.

The Secretary, Mr. E. T. Gregory, having read the notice calling the meeting,

The Chairman moved that the following resolution be confirmed:—"That, notwithstanding anything contained in the Articles of Association, the directors be authorised, and are hereby directed, to carry out the following compromise and modification of the agreement with the vendors, the Union Electric Light and Power Company, Limited, that is to say,—that the directors shall take a surrender of the 11,530 fully paid-up £5 vendors' shares, which were allotted to the Union Electric Light and Power Company, Limited, in consideration of the purchase, and of such of the 470 like shares allotted to their nominees as can be obtained, and that the directors do pay in lieu and consideration thereof a sum not exceeding the amount of £1 3s. 4d. for each of such shares, and that, as hereby modified, the said agreement with the vendors be confirmed."

Mr. F. P. Fellows seconded the motion, which was carried, there being one dissentient only.

The Chairman then moved the second resolution, which was also seconded by Mr. Fellows and carried, being as follows:—"That if an order of the Court be obtained for confirming this resolution, the capital of the company be reduced as follows: (1) By cancelling the 12,000 fully paid-up vendors' shares as and when the same shall be surrendered pursuant to the foregoing resolution, or such of the said shares as shall be so surrendered. (2) By cancelling the sum of £1 per share on the 28,000 shares in the company with £2 10s. called up thereon, and also on any fully paid-up vendors' shares which may not be so surrendered as aforesaid, as being capital which has been lost, or is unrepresented by available assets. (3) By reducing the amount liable to be called up on the 28,000 shares with £2 10s. called up thereon from the sum of £2 10s. per share to £1 10s. And that the memorandum of association of the company be modified so as to carry into effect this resolution."

Mr. John Taylor, who just now entered, said he came to again protest against this scheme as not being an equitable one, and he regretted very much that the board did not agree to consider the measure he proposed at the last meeting, but forced him to take steps to protect his interests in the Courts.

A Shareholder asked Mr. Taylor if he would be kind enough to give those who were not present at the last meeting an idea as to what his reasons were for opposing the scheme.

Mr. Taylor said he had fully stated his reasons, and there was no necessity to discuss the matter now.

The Chairman remarked that Mr. Taylor was a holder of fully-paid £5 shares, which he had purchased from the Union Company, and considered his interests were injured by this proposal.

A Shareholder asked for information as to the capital which was lost.

The Chairman said there was a certain loss acknowledged and pointed out in the balance-sheet for the first year of about £5,000; then there was a sum of £9,000 expended in improving their patents, and in other matters connected with their manufacture, which they considered as a suspense account. Since that a further sum had been expended with the same objects in view. They had not been able to sell or to make profits to the extent which they expected when the year was first closed. Then again, looking at the value of their stock, and the value that could be realised if the possessions of the company were brought to a forced sale, they considered that they could not expect to recover the capital to the extent of £1, or £28,000 in all.

A Shareholder said he hoped £9,000 spent in improvements was not to be considered as lost.

The Chairman: It is not available.

Mr. Parrish, a director, remarked that they were not to take it that quite £28,000 was lost. The fact of the matter was, a certain sum had been lost, as in the case of every other electric light company, without exception, and no future dividend could be paid until that loss was got rid of, which might be done by making profits, when they would have to make up the loss before declaring a dividend; or by writing down the capital, as they proposed to do.

Mr. Edmundson said it was necessary to avoid, if possible, writing off £28,000, and giving the impression that they had paid more for the patents by that amount than they were worth. They had no doubt made a bad bargain, but it was advisable not to state it in that way.

The Chairman observed that the loss had not been incurred in that manner, and, indeed, compared with other companies, they had obtained their patents very moderately. An arrangement had been made whereby they would only pay £37,000 instead of £75,000, as was at first agreed. The patents had stood the test of two years' trial, and were now better known and appreciated than they were when they bought them, so that they had a better marketable article at less than half the price they agreed to give.

The following resolution was then moved by the chairman, seconded by Mr. Edmundson, and carried:—"That the directors be authorised to pay the costs and expenses, amounting to £55, incurred by the committee of shareholders up to the 5th of February, 1884, when their scheme was submitted to the directors, as well as such further costs and expenses as have been, or if the scheme of the committee be adopted by the company, may hereafter be incurred in reference to such scheme."

The Chairman, in reply to Mr. King, said their prospects were now better than ever. They were not earning a profit, nor were they making a loss; they had to earn a profit upon half as much as six months ago. A single installation, which they had a fair prospect of getting, would enable them to declare a dividend. They had decided on cutting down the expenses as much as possible, and they hoped to make an early arrangement that would satisfy the shareholders.

A vote of thanks to the chairman terminated the proceedings.

The German Union Telegraph and Trust Company, Limited.

The following report of the directors is to be presented at the general meeting of this company on the 3rd of April:—

The directors beg to submit the accounts and balance sheet for the 12 months ending 31st December, 1883, including in the accounts the coupon in respect of that date just received from the German Union Company of Berlin. The total receipts during the 12 months amount to £12,635 11s. 8d., which, with a balance of £41 4s. 0d. brought forward from last account, make a total of £12,676 15s. 8d. The expenses for the same period amount to £813 8s. 1d.; of this sum £750 is provided by the German Union Company of Berlin, leaving only a balance of £63 8s. 1d., to the debit of this company for working expenses. Out of the receipts an interim dividend of 5s. 9d. per share was distributed on the 19th of January last, and the directors recommend the payment of a further dividend of 6s. per share, making a total distribution for the year of 11s. 9d. per share, free of income tax, or at the rate of £5 17s. 6d. per cent. per annum (as against £5 5s. 10d. paid last year), leaving a balance of £1 15s. 1d. to be carried over to the next account.

The cables of the Berlin Company, and the whole technical apparatus are in good condition, and no material interruption took place in the year 1883. The storms in the spring of that year, however, destroyed the company's cable house at Lowestoft, which was encroached on by the sea. A new cable house of a substantial kind has been erected, and its capacity is adequate for the purposes of a repeating station, which will improve the telegraphic connection between Great Britain and Germany. The improved working order of the company's telegraph station at Emden has led to a substantial increase in the traffic.

It is satisfactory that, after providing for the 5½ per cent. preference stock of the Berlin Company, there is sufficient to enable an enhanced dividend to be paid on their ordinary stock, and, consequently, on the shares of this company. The reserve and renewal funds of the Berlin Company now amount to £42,500. In addition to this, they have a balance of unexpended capital in hand amounting to £20,500.

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid.	Closing Quotatns, Mar. 26.	Business Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	8	2⅞ - 3½	
		Do. Do.	10	4¾ - 5¼	5
30,000	5	Australasian E. L., Power & Storage Co.	3¼	..	
24,900	10	British Insulite Co., Ld., "A" Shares..	5	..	
30,000	5	Brush Elec. Lt. & Power Co. (Scotland)	2½	..	
25,000	5	Gt. Western Electric Light & Power Co.	2½	¼ - ½	
24,980	5	Hammond Elec. Lt. & Power Sply. Co.	5	1¼ - 1½	
40,000	5	Indian & Ori. Electl. Storage Wks. Co.	2¼	..	
250,000	1	Maxim-Weston Elec. Lt. & Power Co. ..	1	⅛ - ¼	
100,000	5	Metrop. Brush Electric Lt. & Power Co.	3	..	
40,000	5	Pilsen-Joel & Gen. Elec. Lt. Co.	2½	..	
20,000	5	S. African Brush Elec. Lt. & Power Co.	2½	..	
100,000	5	Swan United Electric Light Co., Ld.	3	1 - 1¼	
		TELEGRAPHS.			
1,892,480*l*.	Stk.	Anglo-American, Limited	100	37 - 38	
2,553,760*l*.	Stk.	Do. Pref. } Def. receiving no div. until	100	66 - 67	
2,553,760*l*.	Stk.	Do. Def. { 6 p. c. paid to Pref.	100	9 - 9½	
130,000	10	Brazilian Submarine, Limited	10	9¾ - 10	
16,000	10	Cuba, Limited	10	9¾ - 10¼	
6,000	10	Do. 10 per cent. Preference ..	10	16½ - 17½	
13,000	10	Direct Spanish, Limited	9	4 - 4½	
6,000	10	Do. 10 per cent. Preference ..	10	14½ - 15½	
65,000	20	Direct United States Cable, Ld., 1877 ..	20	10⅝ - 10⅞	
100,000*l*.	100	Do. 6 per cent. Deb., repayable 1884	100	100 -103	
380,000	10	Eastern, Limited	10	10⅞ - 11⅛	
70,000	10	Do. 6 per cent. Preference......	10	12⅞ - 13⅛	
200,000*l*.	100	Do. 5 do. Debs., repayable Aug. 1887	100	101 -104	
200,000*l*.	100	Do. 5 do. do. Aug. 1899	100	102 -106	
250,000	10	Eastern Exten., Australasia & China, L.	10	11¼ - 11½	
320,000*l*.	100	Do. 6 p. c. Debs., repayable Feb. 1891	100	107 - 110	108
500,000*l*.	100	Do. 5 p. c. (Aus. Gov. Sub.) Deb. 1900	100	101 - 104	102½
140,000*l*.	100	Do. do. reg., repayable 1900..	100	102 - 105	
100,000*l*.	100	Do. 5 per cent. Debenture, 1890	100	102 - 105	
550,000*l*.	100	Eastern & South African, Ld., 5 p. c. Mort. Deb. Rg. redeemable 1 Jan. 1900	100	102 - 105	
	100	Do. do. do. To Bearer..	100	102 -105	
22,050	10	German Union Telegraph & Trust, Ld.	10	10 - 10½	
250,000	10	Globe Telegraph & Trust, Ld.	10	6½ - 6¾	
250,000	10	Do. 6 per cent. Preference	10	12½ - 12¾	
150,000	10	Great Northern	10	13½ - 13¾	
100,000*l*.	100	Do. 5 per cent. Debentures ..	100	101 -104	
300,000*l*.	100	Do. 5 per cent. Debentures ..	100	101 -104	
81,200	10	India-Rubber, Gutta-Percha, & Tel. Wks.	10	21 - 22	
100,000	100	Do. 6 per cent. Debs., 1886	100	102 -105	
18,000	25	Indo-European, Limited	25	30½ - 31½	30¾
40,000	10	London Platino-Brazilian, Limited	10	3¼ - 3¾	
12,000	10	Mediterranean Extension, Limited	10	1¼ - 1¾	
3,200	10	Do. 8 per cent. Preference	10	2 - 4	
10,000	8	Reuter's, Limited	8	9 - 9½	
338,225*l*.	Stk.	Submarine	100	185 -195	
75,000	1	Do. Scrip	1	1⅞ - 2⅛	
4,200	Cert.	Submarine Cables Trust	100	100 -103	
37,350	12	Telegraph Construction and Mainten.	12	32½ - 33½	
150,000	100	Do. 6 per cent. Bonds, 1884 ..	100	105 -108	
186,750	5	Do. 2nd Bonus Trust Cert. ..	2½	1¼ - 1¾	
30,000	10	West Coast of America, Limited	10	6¼ - 6¾	
150,000*l*.	100	Do. 8 per cent. Debs.	100	108 -110	
45,791	15	Western and Brazilian, Limited	15	5¼ - 5¾	
24,119	7½	Do. Preferred	7½	4¼ - 4¾	
24,119	7½	Do. Deferred	7½	⅞ - 1⅛	
200,000*l*.	100	Do. 6 p. c.. Debs. "A." 1910 ..	100	103 -106	
250,000*l*.	100	Do. 6 p. c. Mort. Deb. B. '80, red. Feb. 1910	100	98 -101	
1,500	$1,000	Western Union 7 p. c. 1 Mort. (Bg.) Bds.	$1,000	122 -126	
1,030,000*l*.	100	Do. 6 per cent. Sterling Bonds	100	102 -106	
88,321	10	West India and Panama, Limited	10	¾ - 1	
34,563	10	Do. 6 per cent. 1st Preference	10	6¾ - 7¼	
4,669	10	Do. 6 do. 2nd do. ..	10	4¾ - 5¼	
		TELEPHONES.			
224,850	1	Con. Tele. & Mainten., L., Nos. to 154,165	1	¼ - ⅜	
225,000	1	Oriental Tele. Co., Nos. 80,001 to 300,000	½	¼ - ½	
100,000	5	United Telephone Co.	5	8 - 8½	
20,000	5	Do. New, issued 2 p.m.	2	..	

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th March are £2,765 as compared with £4,339 in the corresponding period of 1883. The December receipts, estimated at £4,466, realised £4,565.

NEW PATENTS—1884.

5138. "Electro motors and generators." O. March. Dated March 19.

5149. "Method of protecting insulated, telegraphic, telephonic, and other electrical conductors laid in pipes and channels." A. R. Bennett. Dated March 19.

5157. "Electric jewellery and ornaments." A. M. Clark. (Communicated by G. Trouvé.) Dated March 19.

5200. "Secondary piles or batteries." P. Nolet. (Communicated by M. Glaesener and J. B. Glaesener.) Dated March 20.

5208. "Means of connecting incandescence lamps to their holders. A. Duffin. Dated March 20.

5214. "Method of regulating the distribution and translation of electric energy." J. S. Beeman. Dated March 20.

5223. "Manufacture of non-conducting or insulating material." H. Bolze. Dated March 20.

5287. "Producing and regulating electric currents." N. B. Dennys, J. C. Cuff. Dated March 22.

5304. "Manufacture of electrodes for primary or galvanic electric batteries." T. Rowan. Dated March 22.

5309. "Combined holder and gallery for incandescent electric lamps." W. Harvie. Dated March 22.

5310. "Instruments for testing electrical cables." J. L. Clark. (Partly communicated by H. C. Mance.) Dated March 22.

5315. "Electrometer." H. R. Cassel. Dated March 22.

5321. "Bells known as call or alarm bells." B. R. Jackson. Dated March 22.

5335. "Dynamo-electrical machines." Sir W. Thomson, S. Z. de Ferranti. Dated March 22.

5337. "Secondary batteries." S. Kalischer. Dated March 22. (*Complete.*)

5351. "Portable electric bells." W. E. Irish. Dated March 24.

5355. "Voltaic batteries." R. H. Courtenay. Dated March 24. (*Complete.*)

5362. "Telephone support or holder." G. W. Errington, F. Caws. Dated February 1.

5390. "Telegraphic systems." W. P. Thompson. (Communicated by C. G. Burke. Dated March 25. (*Complete.*)

5408. "Producing electrotyping moulds from typographic printing and other similar surfaces." W. Lowe, D. Cavagna. Dated March 25. (*Complete.*)

5409. "Secondary batteries." G. Prescott, M. F. Purcell, D. Sherlock, W. H. Dunne. Dated March 25.

5416. "Portable sealed galvanic battery cell, specially adapted for use in combination with an inductorum enclosed within a dumb-bell or other exercising apparatus." H. J. Allison. (Communicated by J. H. Shaw.) Dated March 25.

5421. "Supporting and driving dynamo-electric machines in railway vehicles." W. R. Lake. (Communicated by J. W. Boothby.) Dated March 25.

5455. "Means or apparatus for regulating and controlling by electricity the speed of steam and other motors used for driving electric machinery or for other purposes." W. Balls, W. H. Tozer. Dated March 25.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1883.

3451. "Electric batteries and lighting apparatus." P. de Villiers and E. F. Rey. Dated July 13. 6d. Relates partly to an electric primary battery designed to produce electricity for all industrial and domestic purposes, such as electric lighting both public and domestic, for the transmission of power to motors, for telegraphs, telephones, and other apparatus of the same class, electric bells, electric clocks, the deposition of metals by the processes of gilding, silver plating, platinum or nickel plating, or the like; and for other purposes to which electricity may be applied. Also relates to apparatus suitable for the production of electric light for illuminating public streets and buildings, factories, yards, private houses, railway stations, lines and carriages.

3457. "Electric machines." W. S. Frost. Dated July 13. 2d. The object of the invention is the production of an engine whereby a continuous current of electricity may be mechanically maintained without the continuous use of steam, or any other prime mover. The inventor proposes to attain this object by means of a machine or apparatus which shall derive from an ordinary accumulator, or any other power, sufficient force to start an ordinary or any dynamo-electric machine, or other electric current generating machine, and then, when the current from the accumulator, or other starting power, is cut off therefrom, shall be continuously driven by the current generated by such dynamo-electric machine or other electric current generating machine, and being on the same axle as the dynamo-electric machine or other electric current generating machine, or connected therewith by band, or otherwise, will continuously and automatically drive the same, a continuous current of electricity being thus maintained, which may be applied to electric lighting, or any other purpose for which electricity is now or may be found applicable!!!! (*Provisional only.*)

3459. "Voltaic Batteries." A. Clark. Dated July 13. 2d. Relates to improvements in single and double fluid batteries. (*Provisional only.*)

3464. "Electric current switches and cut outs." H. J. Haddan. (Communicated from abroad by C. G Perkins, of New York.) Dated July 13. 4d. Relates to applying in connection with storage batteries, a vessel containing mercury for operating suitable mechanism for changing the current after the batteries have been charged. (*Provisional only.*)

3465. "Electric incandescent lamps, &c." H. J. Haddan. (Communicated from abroad by C. G. Perkins, of New York.) Dated July 13. 4d. Relates chiefly to an electric incandescent lamp, having an opening in the wall of its neck, through which plaster of Paris is poured for the purpose of holding the electrical conductors in position, and also for holding suitable means therein in such a manner as will hold the lamp rigid to a switch box made therefor. (*Provisional only.*)

3466. "Apparatus for treating carbon filaments." H. J. Haddan. (Communicated from abroad by C. G. Perkins, of New York.) Dated July 13. 2d. Relates to an oil reservoir provided with a tap for the reception of a metallic pipe, which is made fast thereto, and extending therefrom at a suitable distance, at which point it is connected with a glass tube, having two globular enlargements integral therewith, the said tube is provided with stop-cocks opposite the said globular enlargements. One of the globes is provided with a hollow projection, having a soft rubber pouch mounted thereon. The farther end of the glass tube is mounted with a second soft rubber pouch with its opposite end mounted on a metallic pipe, having a stop-cock thereon; the said pipe is connected with another leading into a chamber, wherein carbon filaments are placed for their final treatment. (*Provisional only.*)

3475. "Recording and controlling a supply of electricity." J. Hopkinson. Dated July 13. 6d. Relates to measuring the quantity of electricity which has passed through a given conductor in any time, and to breaking the electric circuit if the current passing should become too great, or if any part of the circuit should be in electric connection with the earth.

3478. "Apparatus for connecting or disconnecting portions of electric conductors. C. A. C. Wilson. Dated July 14. 6d. The apparatus consists of a metallic box or cylinder, having at its two extremities stuffing boxes provided with glands and bolts for tightening up the glands. This arrangement is to allow of the expansion or contraction of the conductors with the temperature. The centre line of the glands may be at any angle to one another so as to allow for bends in the line of conductors. The box is also provided with a small opening at the top, which can be closed by a screw stud. The extremities of the conductors to be joined are inserted in the apertures at the ends of the box so as to come within a short distance of one another inside the box, and the stuffing boxes filled in with suitable material. The glands are then tightly screwed up so that the packing bears hard on the surface of the conductors and makes a good mechanical joint. Mercury is then poured in by the opening at the top so as to nearly fill the box.

3495. "Chemical deposit current meters used in charging and discharging accumulators employed for storing electricity." Sir David Salomons. Dated July 16. 4d. Relates to improvements in chemical deposit current meters used in the process of charging and discharging accumulators employed for storing electricity. According to the improvements the inventor proposes to remedy certain defects by placing a "resistance" in the shunt current circuit of the meter when charging and removing the resistance when discharging.

3505. "Telephonic apparatus." J. Graham. Dated July 17. 8d. Have for their object the production of telephonic apparatus which will obviate many difficulties attendant on electric telephony arising from inductive influences, and also to render long distance telephony practical any easy.

3516. "Electrical signalling apparatus chiefly for telephonic purposes." W. R. Lake. (Communicated from abroad by J. H. Cary, of America.) Dated July 17. 1s. Relates to signalling apparatus for use in electrical systems, and particularly to telephone systems, where a number of sub-stations are located on one line radiating from a central operating station, and has for its object to provide a new and simple system of calling any particular sub-station without signalling any other sub-station on the line.

3533. "Electric meter." W. McWhirter. Dated July 18. 6d. Relates to apparatus for measuring and indicating electrical currents in a circuit. The inventor constructs an electric meter as shown by the figs. Fig 1 is a front view, the dial being supposed to be removed to show the interior. Fig 2 is a vertical section, and fig. 3 is a plan. Fig 4 is an end view of the axis. On a horizontal axis, A, is fixed near one end an index or pointer, C, of light material, and also on the axis, A, parallel with the pointer, C, is fixed a needle, B, of soft iron, the pointer and needle being normally maintained in a vertical attitude by means of an adjustable counterweight, D, suspended from the axis, A. Immediately under the soft iron needle, B, is placed a vertical electro-magnet, M, which magnetises the needle by induction when a current is passed through its coils. On each side of the soft iron needle, B, is a helix, E, of insulated wire, so that, on the current being passed through these helices, the needle, B, is deflected, and the pointer, C, indicates the amount of deflection on a graduated scale marked on a dial, F. When the instrument is intended to be used for measuring currents, the coil of the electro-magnet, M, and the helices, E, should be of thick wire having low resistance. If the instrument is to be used as a power meter the mechanical construction remains the same, but the coil of the electro-magnet, M, instead of being of low resistance, is of fine wire, of high resistance, and instead of being, along with the helices, in the main circuit as shown, the electro-magnet, M, is in a by-pass circuit between the points of the circuit in which the power is to be measured. For use as a voltmeter, the whole instrument is wound with fine wire to a high resistance. As a change in the direction of the current flowing through the coils of the instrument causes a reversal in the polarity of the induced needle, B, as well as a reversal in the polarity of the needle coils, E, the deflection is independent of the direction of current, and the instrument is applicable for indicating alternate, as well as continuous currents. One of the coils, E, may be dispensed with, or the two coils may be of different powers, the one or the other being brought into use by a switch. The soft iron needle, B, may be made of various forms, some of which are shown in fig. 5. Also the working parts may be so arranged that the needle hangs down from its axis, in which case the counterweight can be dispensed with.

FIG I

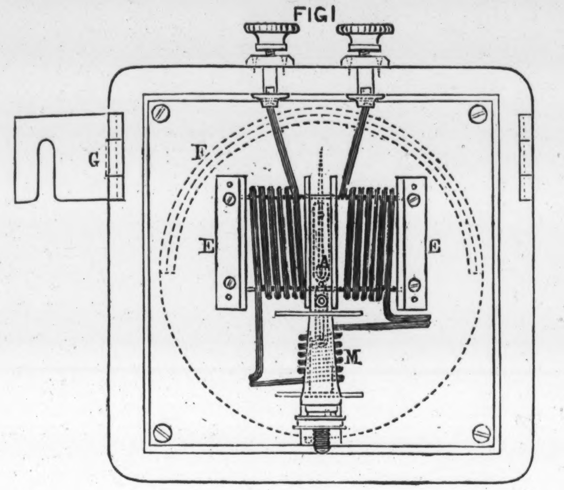


FIG.2.

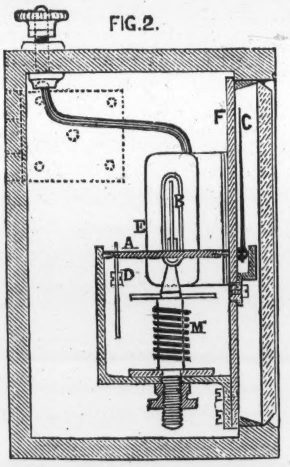


FIG 4.

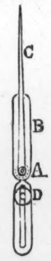
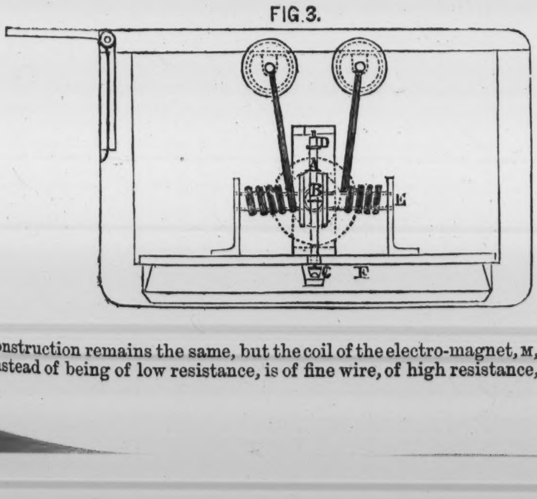


FIG.3.



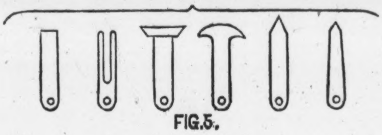


FIG.5.

3553. "Electric meters." G. HAMMERSLEY and C. H. WORSEY. Dated July 19. 6d. Relates to apparatus for measuring and registering the electrical power passing through a circuit. For this purpose, according to one arrangement, the inventors provide clockwork, which may be worked by the electricity passing through the circuit or part thereof, and which is timed by a balance or pendulum to an approximately uniform speed. To this clockwork is connected a pair of levers for working the reciprocating pawl of a counter, this pawl preferably acting, not on teeth, but as a silent feed. There is a pin, movable along slots in the two levers, so as to approach the fulcrum of the one as it recedes from the fulcrum of the other. The pin is moved by the core of a controlling solenoid excited by the current or a known fraction thereof, the position of the pin in the slots of the two levers being thus made dependent on the amount of current. The one lever being caused to reciprocate by the clockwork, causes the other lever to give to the counter, at each stroke, an amount of feed proportional to the current, and therefore the counter, in a given time, registers a total proportional to the current that has passed in that time.

4964. "Transmitting and reproducing sounds at a distance, &c." A. G. BROOKES. (Communicated from abroad by T. N. Vail, of America.) Dated October 18. 6d. Consists of two flat coils in close proximity to each other, one of which has a current circulating in it, and is vibrated by the action of the voice, so as to induce currents in the second coil.

CORRESPONDENCE.

British Spiral Telephone Wire Syndicate, Limited.

We are much surprised by the highly libellous article under the head of "Misleading Reports," in your issue of 22nd inst., by which you state that this syndicate was formed "as an extraordinary attempt to obtain money from the pockets of the investing British public." We absolutely deny that there is any truth whatever in your statement, and to confirm this we beg to refer you to the annexed letter which was published in various papers on the day your article of which we complain appeared. Knowing the merit and value of the invention we should have been content to wait until it had been as fully proved here, as it has been proved elsewhere, that the spiral wire does all that is claimed for it, but that some of the friends of the syndicate have suggested that we should write to deny your statements, and to ask you as a matter of common justice and fairness to suspend your hostile criticism pending the proof to which we have referred.

W. H. Smith & Son,
Solicitors to the Company.

Gresham House, Old Broad Street,
London, *March* 26*th*, 1884.

"SPIRAL TELEPHONE WIRE.

"SIR: In Mr. Lumley's certificate, under date 25th ult. (which, so far as known to any person connected with this syndicate, was never intended to be used 'privately'), it will be observed that he distinctly states that the tests when made by him were made and compared with the *wires*, not 'one wire,' as stated by Mr. Bennett. Then Mr. Bennett in his letter admits that the speaking on all the wires was good, *i.e.*, *including the spiral wire*. He, however, forgets to touch upon that part of Mr. Lumley's certificate which reads as follows :—

"'The wire is No. 13 gauge, and weighs 110 lbs. to the mile, against 220 lbs. of the ordinary No. 11 iron wire, generally in use for telegraphic and telephonic purposes. Its lightness makes it much easier to manipulate ; the cost of erection will thus be reduced as against the No. 11, and the public safety much increased. At one time the tests were made under specially disadvantageous circumstances for the spiral wire, it being in contact with another wire, but this seemed in no way to affect the speaking.'

"This, and the fact that the spiral wire speaks well, as admitted both by Mr. Lumley and Mr. Bennett, is all that can possibly be expected from the spiral wire for short distances.

"The inventor, however, asserts that with the spiral wire he has talked, and can talk *clearly* and *in whispers* in all kinds of weather, at a distance of nearly ninety miles. This fact has been fully proved in the United States, and a sufficient quantity of the wire is now on its way from that country, so that positive proof will also be afforded in England.

"The following communications recently received from gentlemen of the highest standing, and who are all connected with telephone companies, fully corroborate the statements made by the inventor.

"The vendor will not touch one penny of the money belonging to the syndicate until the long distance speaking has been fully verified to the satisfaction of the directors.—Yours, &c.,

"W. H. SMITH AND SON,
"Solicitors to the Company.

"Gresham House, *March* 18, 1884."

[Whilst not admitting the first statement of Messrs. Smith & Son's letter to us as correct, we have no objection to suspend our further criticism for a while, to see what proof is forthcoming. The fact stated in the second letter, that the inventor "asserts that with the spiral wire he has talked, and can talk *clearly* and *in whispers* in all kinds of weather, at a distance of nearly 90 miles." proves very little, because much greater distances have been spoken over as satisfactorily with wire of the ordinary kinds. The last paragraph but one is unintelligible without copies of the communications mentioned. We retract nothing we have said, knowing that our criticisms will be fully borne out by *conclusive* tests.—EDS. ELEC. REV.].

Private Electric Lighting.

Thinking it may interest some of your many readers, as showing the ease, comfort, and certainty of the use of accumulators for lighting purposes under similar circumstances, I give you the following particulars of a small installation at my brother's house, 20, Warwick Crescent, Maida Vale, W. On Friday, the 4th inst., Mr. Heywood gave a ball, the reception-rooms being lighted by electricity : 30 1½ horse-power Faure-Sellon-Volckmar accumulators were used, the rooms (three) were lighted from half-past 7 p.m. to 4 a.m. (it being arranged that the cells should not be removed until the Monday following). The light was again used for four hours on the 15th, and again for four hours on the 16th ; on each of these occasions the light was simply perfect, and the admiration of all.

The comfort was beyond description, as was evidenced by all my brother's guests.

A very pretty and effective arrangement was made by having the incandescent lamps disposed in baskets of ferns and flowers hanging round the rooms.

The installation was fitted and completed in a couple of evenings by Mr. G. Annesley Grindle, electrician, assisted by

H. Cleland Heywood.

19, Great Winchester Street, E.C.,
March 20th, 1884.

The New Patent Act.

Mr. Handford has set out in his letters the provisions of clause 45 of the New Patent Act, but he has not set out clause 113, which enacts that the repeal of the then existing Acts set out in the 3rd schedule "shall not" . . . . "affect the past operation of any of those enactments, or any patent or copyright or right to use a trade mark granted or acquired, or application pending, or appointment made, or compensation granted, or order or direction made or given, or right, privilege, obligation, or liability acquired, accrued, or incurred, or anything duly done or suffered under or by any of those enactments before or at the commencement of this Act ; or," &c.

How these provisions will be reconciled it is not for me to suggest ; but it is not likely that Parliament would intentionally have released then existing patents from the law making them void on the expiration of a foreign patent of earlier date, and, at the same time, made them free from the, to some extent, compensating liability of granting licences.

H. B. T. Strangways.

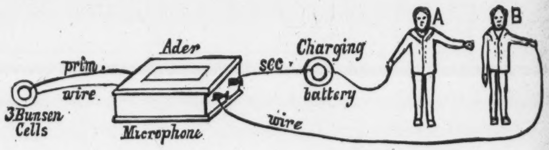
5, Pump Court, Temple, E.C.,
March 25th, 1884.

Telephonic Experiments.

A short time ago I made an experiment, which shows in a remarkable manner by what simple means telephonic communication is possible.

It is a well known fact, discovered by Dunand, that a tinfoil-paper-condenser makes an admirable telephonic receiver, as soon as it is charged permanently by a small battery, placed in the line.

Now, any two conductors placed near to each other, and separated by some insulator, can be said to make a condenser. As the human body is a conductor, though of high resistance, it occurred to me that it must be possible to employ two human bodies, separated by some insulator, as a telephonic receiver.



I made the experiment in the following manner :

An Ader-microphone (see the accompanying figure), was connected with the primary of a small induction coil, (placed inside the microphone-box) and with 3 Bunsen cells. The secondary of the coil was joined to two lines, leading to another room where two persons, A and B, were standing. A charging battery of 9 Leclanché-cells was somewhere put in the line, as shown in the sketch. A took one of the line-wires into his right hand, while his left wore a common kid glove. B took the other line into his left hand. Now, some melody was loudly whistled or sung, close to the diaphragm of the microphone. As soon as A pressed his gloved hand firmly against the ear of B, the latter *clearly heard the melodies*, sung before the microphone, *come out of the glove*. Whistling gave much better results than singing. Of speech, only a few words were understood, as the sounds were too feeble. With a charging battery of greater difference of potentials, and perhaps with an induction coil of higher secondary resistance, I don't doubt, but speech would be perfectly given out by the gloved hand. The secondary wire of my coil had a resistance of some 300 Ohms.

J. W. Giltay.

Delft, March, 1884.

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